CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

VOLUME 3, PARTS 2 - 4

JUNE - DECEMBER, 1927

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CONTENTS

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40. PENNSYLVANIAN FORAMINIFERA FROM MICHIGAN

By JOSEPH A. CUSHMAN and JAMES A. WATERS

The material on which this short paper is based was collected by the junior author from the Saginaw formation of the Middle Pennsylvanian near Grand Ledge, Eaton Co., Michigan. Two lots of material were collected just across the line in Clinton County, one from Carbonaceous shale above the 20 inch coal bed which occurs at this locality, and the other from the *Lingula* bed below the same coal bed. A very striking difference in the foraminiferal faunas of these two beds is at once noted, no genus or species occurring in one occurring in the other. All the foraminifera are small, some of them very small indeed. In the upper bed there are great numbers of *Glomospira pusilla* (Geinitz) with a few *Ammobaculites*. In the lower bed the most common species is *Ammodiscus annularis* (H. B. Brady) with fewer numbers of the other species noted. The preservation of the specimens is good, and numerous ostracods occurring in the same material have the calcareous shells well preserved.

Several of the species cannot be distinguished from those already described from the Carboniferous of Europe, and a few appear to be undescribed. All are simple forms belonging to the primitive arenaceous group of the foraminifera.

GLOMOSPIRA PUSILLA (Geinitz)
Plate 22, figures 1 *a*, *b*

Serpula pusilla GEINITZ, Verstein. deutsch. Zechstein., pt. 1, 1848, p. 6, pl. 3, figs. 4-6.—JONES, in King, Pal. Soc., 1850, p. 57, pl. 6, figs. 7-9; pl. 18, figs. 13 *a-d*.

Trochammina pusilla JONES, PARKER and KIRKBY, Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 390, pl. 13, figs. 4-6, 15.—H. B. BRADY, Pal. Soc., vol. 30, 1876, p. 78, pl. 3, figs. 4, 5.

There are very abundant specimens of this species, irregular in form, as the earlier figures quoted show more plainly than do those of Brady. The one here figured is one of the more regular ones. The test is arenaceous, irregularly winding, but usually the test is broader than thick. The Michigan specimens measured from 0.25-0.40 mm. in diameter.

AMMOBACULITES COMPRESSA Cushman and Waters, new species
Plate 22, figures 2 *a*, *b*

Test with the early portion close coiled and much compressed, of two or three coils, four to six chambers in each coil, the later portion uncoiled, consisting of a few chambers in a rectilinear series, also compressed; wall arenaceous, fairly thick; aperture elliptical, terminal. Length up to 0.60 mm.

Holotype (Cushman Coll. No. 6594) from carbonaceous shale of Saginaw formation, Middle Pennsylvanian, above the 20 inch coal bed near Grand Ledge, Clinton Co., Michigan.

Some of the specimens show a larger proportion of uncoiled chambers.

AMMODISCUS ANNULARIS (H. B. Brady)
Plate 22, figures 3 *a*, *b*

Trochammina annularis H. B. BRADY, Pal. Soc., vol. 30, 1876, p. 76, pl. 3, figs. 9, 10.

Test minute, planispiral or somewhat irregular, consisting of a proloculum and elongate tubular second chamber of even diameter, nearly circular in section; wall coarsely arenaceous for the size of the test; aperture formed by the open end of the tube, nearly circular. Maximum diameter, 0.17 mm.

Brady described and figured the later coils of this species. The inner portion is easily broken away although in the material from the *Lingula* bed below the coal bed it is common, and most of the specimens are complete. Many specimens were measured,

and the maximum seems to be exactly the same as that given by Brady for his English specimens. There is very little irregularity in the shape of the Michigan specimens, nearly all of them being regularly planispiral.

PSAMMOPHIS INVERSUS Schellwein
Plate 22, figure 4

Psammophis inversus SCHELLWEIN, Palaeontographica, vol. 44, 1897, pl. 23, fig. 10.

The specimen figured seems to be very close to or identical with Schellwein's species. It is less regular than his figure, and in this respect is more nearly like figures given by Rhumbler and referred to *Tolypammina vagans* (H. B. Brady). These appear to belong to *Psammophis,* the characters of which are an arenaceous attached test, the early coils of which are planispiral, and the later ones winding back and forth at one side as shown in our figure. The specimen figured is a small one and is attached to a fragment of shale.

TURRITELLELLA SPIRANS Cushman and Waters, new species
Plate 22, figures 5, 6

Test arenaceous, consisting of a proloculum and long tubular second chamber coiled in an elongate spiral, the tubular chamber circular in section, early portion with the sides nearly parallel, later portion more fusiform; wall arenaceous; apertural end somewhat projecting forward and slightly contracted at the rounded aperture. Maximum length, 0.37 mm.; breadth, 0.15 mm.

Holotype (Cushman Coll. No. 6599) from *Lingula* bed below 20 inch coal bed near Grand Ledge, Clinton Co., Michigan.

This brings this genus back to the Palaeozoic which is really not surprising as several of the genera of the Ammodiscidae, *Ammodiscus, Psammophis, Tolypammina, Ammolagena, Glomospira, Hemidiscus* and *Lituotuba* have been found in the Carboniferous, leaving only *Ammodiscoides* and *Psammonyx* not occurring there. These two genera are known only from the Recent oceans.

HYPERAMMINA BULBOSA Cushman and Waters, new species
Plate 22, figures 7 *a, b*

Test with a fairly large proloculum broader than the tubular second chamber, flattened at one side, convex on the other, the

tubular chamber nearly circular in transverse section; wall arenaceous; aperture formed by the open end of the tube. Length variable, diameter of the tubular chamber 0.10 mm.

Holotype (Cushman Coll. No. 6601) from *Lingula* bed, below the 20 inch coal bed near Grand Ledge, Clinton Co., Michigan.

The peculiar shape of the proloculum seems to be a constant and unusual character. The tubular chamber has a somewhat sinuous border with regular enlargements and contractions of small amount but noticeable. These do not represent chamber divisions.

ENDOTHYRA BOWMANNI (Phillips)

Plate 22, figures 8 *a, b*

Endothyra bowmanni PHILLIPS, Rept. Proc. Geol. Poly. Soc. West Riding Yorkshire, 1844-45 (1846), p. 277, pl. 7, fig. 1.—H. B. BRADY, Pal. Soc., vol. 30, 1876, p. 92, pl. 5, figs. 1-4.

Specimens of rather small size, but in general with the characters of this species, occur in some numbers in the *Lingula* bed below the 20 inch coal bed.

TROCHAMMINA RUDIS Cushman and Waters, new species

Plate 22, figures 9 *a-c*

Test trochoid, of several whorls, chambers fairly distinct, increasing rapidly in size as added, in the adult three or sometimes four making up the whorl, dorsal side somewhat convex, ventral side slightly convex with deep depressions between the chambers; sutures fairly distinct; wall rather coarsely arenaceous with a distinct reddish cement; aperture on the ventral side. Diameter, 0.30-0.35 mm.

Holotype (Cushman Coll. No. 6603) from *Lingula* bed, below the 20 inch coal bed near Grand Ledge, Clinton Co., Michigan.

This species is somewhat variable in form, but in general has three chambers in a whorl in the adult. The coarsely arenaceous wall and very reddish cement are constant in all the specimens.

Besides the species already noted, there is a single specimen appearing to be a very small *Fusulinella,* but no other specimens to check this were obtained. An examination of larger lots of material will undoubtedly give a larger fauna. While some of these species also occur in the Pennsylvanian of the South Western United States, the Michigan specimens are all very small and agree more closely with European material.

41. NEW AND INTERESTING FORAMINIFERA FROM MEXICO AND TEXAS

By JOSEPH A. CUSHMAN

The study of Upper Eocene material from Mexico in the Alazan Clay and of the Upper Cretaceous of Mexico and Texas has brought to light a number of interesting species, a few of which are noted here. Descriptions of these follow:

VULVULINA SPINOSA Cushman, new species
Plate 23, figure 1

Test comparatively large, compressed, the periphery acute and with a spinose process at the basal peripheral angle of each chamber; early portion biserial, later chambers uniserial; sutures depressed, especially those of the later portion; wall finely arenaceous with a large proportion of gray cement, and the whole neatly and smoothly finished; aperture in the early portion a low transverse slit, in the adult terminal, elliptical. Length 1.30 mm.; breadth nearly 1 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 901) from Alazan Clay, Rio Buena Vista, just south of crossing of Alazan to Moyutla Road, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

This species which is peculiar in the angular projections also apparently occurs in Trinidad and probably in Ecuador. It is quite distinct from *Vulvulina advena* Cushman from the Eocene of the Gulf Coastal Plain.

FRONDICULARIA TENUISSIMA Hantken
Plate 22, figure 11

Frondicularia tenuissima HANTKEN, A. magy. kir. földt. int. evkönyve, vol. 4, 1875 (1876), p. 36, pl. 13, fig. 11; Mitth. Jahrb. ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 43, pl. 13, fig. 11.

Test very much compressed, generally elliptical in face view, tapering at the ends, the periphery rounded, initial end often with a spinose process; chambers numerous, very elongate, early ones in a loose coil, later ones extending to the base at either side; sutures distinct, curved, slightly depressed; wall smooth, very finely perforate; aperture terminal, radiate. Length up to 2 mm.

This species described by Hantken from the *Clavulina-szaboi* beds of Hungary occurs in considerable numbers in the Alazan Clay from Rio Buena Vista, 0.5 km. S. 25° E. from Tumbadero Hacienda House, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

PLECTOFRONDICULARIA TRILINEATA Cushman, new species
Plate 23, figure 2

Test much compressed, elongate, slightly tapering, very slightly keeled, median portion of the test thickest, with three elongate slightly raised sharp costae continuous over the length of the test; chambers numerous, earliest ones biserial, later ones uniserial and extending backward on either side; sutures distinct, slightly curved, oblique, not depressed; wall smooth except for the three costae, and finely perforate; aperture terminal, elliptical, not radiate. Length 0.85 mm.; breadth 0.25 mm.; thickness 0.10 mm.

Holotype (U. S. Nat. Mus. No. 369299) from Alazan Clay, Rio Buena Vista, 9.8 kms. in a straight line upstream from Tumbadero, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

PLECTOFRONDICULARIA VAUGHANI Cushman, new species
Plate 23, figure 3

Test much compressed, broadly elliptical in front view, initial end broadly rounded; chambers distinct, early ones coiled about the proloculum, then biserial and in the adult extending back on either side; sutures distinct, only slightly depressed, with a slight depression in the curve on opposite sides in succeeding chambers; wall smooth, finely perforate; aperture terminal, elliptical. Length up to 0.60 mm.; breadth 0.40 mm.

Holotype (U. S. Nat. Mus. No. 369300) from Alazan Clay, Rio Buena Vista, 9.8 kms. in a straight line upstream from Tumbadero, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

This species is peculiar in the retention of the alternating character of the chambers as shown by the apertures pointing first to one side then the other in succeeding chambers and the incurved portion of the wall even after the alar projections are developed. The species occurs at a number of localities in the Alazan Clay.

PLECTOFRONDICULARIA ALAZANENSIS Cushman, new species

Plate 22, figures 12 *a, b*

Test much compressed, elongate, tapering, with a broad thin clear peripheral keel, early chambers biserial, later ones uniserial, slightly inflated, sutures slightly depressed, very slightly oblique; wall thin, ornamented with several sharp narrow longitudinal costae, finely perforate; aperture elliptical, terminal. Length up to 1 mm.; breadth 0.40 mm.

Holotype (U. S. Nat. Mus. No. 369301) from Alazan Clay, Rio Tuxpan, crossing of road from Palo Blanco to La Noria and along Rio Pantepec about 200 meters above its mouth, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

This is the most highly ornamented of the Alazan species, the costae often standing well above the surface of the test.

PULVINULINELLA INTERRUPTA Cushman, new species

Plate 22, figures 10 *a-c*

Test trochoid, unequally biconvex, the dorsal side nearly flat, periphery with a thin keel ending in a distinct projection at the peripheral margin of the base of each chamber; chambers distinct especially those of the last coil, about seven making up the adult coil, slightly inflated on the ventral side; sutures slightly limbate and flush on the dorsal side, oblique, on the ventral side gently curved, depressed; wall smooth, finely perforate; aperture elongate at a high angle to the periphery on the ventral side. Diameter 0.50 mm.; thickness 0.20 mm.

Holotype (U. S. Nat. Mus. No. 369302) from type locality of the Alazan Clay, Rio Buena Vista, just south of crossing of Alazan to Moyutla Road, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

This species is related to *Pulvinulinella culter* (Parker and Jones) but differs in the smaller number of chambers and the peculiar peripheral margin.

PLANULINA MEXICANA Cushman, new species

Plate 23, figures 5 *a, b*

Test very much compressed, complanate, the periphery broadly rounded, not keeled, sides flattened; chambers numerous, 10-12 in the final whorl, narrow, curved; sutures limbate but not raised, distinct, curved; wall coarsely perforate otherwise smooth; aperture peripheral, narrow, at the base of the narrow peripheral face of the chamber. Diameter 1.30 mm.

Holotype (U. S. Nat. Mus. No. 369303) from Alazan Clay, Rio Buena Vista, 0.5 km. S. 25° E. from Tumbadero Hacienda House, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

This is one of the largest and finest species in the Alazan Clays.

GLOBOROTALIA SPINULOSA Cushman, new species

Plate 23, figures 4 *a-c*

Test biconvex, the dorsal side somewhat less so than the ventral, periphery with a spinose keel; chambers distinct, 4 or 5 in the final whorl, somewhat inflated on the ventral side, sutures very slightly if at all depressed on the dorsal side, slightly depressed on the ventral, nearly radial; wall at the periphery with short spines becoming more prominent in older specimens, the dorsal side with the early chambers roughly granular, later ones smooth and finely perforate, ventral side smooth; aperture large, on the ventral side. Diameter up to 0.40 mm.

Holotype (U. S. Nat. Mus. No. 369304) from Alazan Clay, Rio Tuxpan, crossing of road from Palo Blanco to La Noria and along Rio Pantepec about 200 meters above its mouth, Vera Cruz, Mexico, collected by Dr. T. Wayland Vaughan.

In older specimens than that figured the middle of the periphery of each chamber becomes more projecting and the spinose projections somewhat larger and flatter.

SPIROPLECTOIDES ROSULA (Ehrenberg)

Plate 23, figures 6, 7

Spiroplecta rosula EHRENBERG, Mikrogeologie, 1854, pl. 32, pt. 2, fig. 26.
Spiroplectoides rosula CUSHMAN, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 1, 1927, p. 62, pl. 13, figs. 9 *a, b*.

Test with a close coiled young, planispiral, later chambers in a biserial, parallel sided, flattened test, the chambers numerous and oblique; wall smooth, polished.

Figured specimen (Cushman Coll. No. 6699) Upper Cretaceous, Pecan Gap Chalk, roadside ditch along pike, 1.8 mi. N. E. of Rockwall, Texas, collected by Mrs. Helen Jeanne Plummer.

This species was found by Ehrenberg in material from the Cretaceous of America. Figure 6 is a copy of his original figure which was from a specimen mounted in balsam. The species is found in the Upper Cretaceous of the United States and Mexico, and a very similar species is now living in the waters of the Philippine region.

PSEUDOUVIGERINA PLUMMERAE Cushman, new species

Plate 23, figures 8 *a*, *b*

Test small, earliest chambers in the microspheric form planispiral, later ones biserial and those of the adult triserial; chambers distinct slightly inflated, the periphery truncate and the margins crenulate; sutures slightly depressed, distinct; wall smooth, finely perforate; aperture circular, terminal, without a tooth. Length 0.35 mm.; breadth 0.10 mm.

Holotype (Cushman Coll. No. 6700) from Upper Cretaceous, Pecan Gap Chalk, roadside ditch along pike, 1.8 mi. N. E. of Rockwall, Texas, collected by Mrs. Helen Jeanne Plummer.

This species is a small one, but has distinctive characters from *P. cristata* (Marsson) which it most nearly resembles. The crenulated edges of the raised periphery are peculiar.

BOLIVINITA PLANATA Cushman, new species

Plate 23, figures 9 *a*, *b*

Test compressed, tapering, edges truncate, concave, broad faces flattened; chambers distinct; sutures limbate but not raised; wall smooth and unornamented; aperture at the peripheral margin of the last-formed chamber. Length 0.50 mm.; breadth 0.25 mm.; thickness 0.08 mm.

Holotype (Cushman Coll. No. 6701) from Upper Cretaceous, Pecan Gap Chalk, roadside ditch along pike, 1.8 mi. N. E. of Rockwall, Texas, collected by Mrs. Helen Jeanne Plummer.

This is to be distinguished from the much narrower *B. eleyi* Cushman which also occurs in the Upper Cretaceous.

GLOBOTRUNCANA CALCARATA Cushman, new species

Plate 23, figures 10 *a*, *b*

Test trochoid, umbilicate, dorsal and ventral sides nearly parallel, the sides angled, obliquely truncate; chambers 4 or 5 in the final whorl, each with a stout peripheral spine, the early ones roughened with spinose projections as are the spines; sutures distinct, on the dorsal side oblique and marked by a bead-like ornamentation, ventrally radial, slightly depressed; aperture opening onto the umbilical region. Diameter with spines 0.40 mm.

Holotype (U. S. Nat. Mus. No. 73419) from Upper Cretaceous, Pecan Gap Chalk, cut in G. C. and S. F. R. R., at N. edge of Farmersville, Texas, collected by Dr. L. W. Stephenson.

This is related to *Globotruncana arca* (Cushman), but is dis-

tinct in the large, well developed peripheral spines. The species also occurs in the Mendez Shales of the Tampico Embayment, Mexico.

GLOBOTRUNCANA CANALICULATA (Reuss)

Plate 23, figures 11 *a-c*

Rosalina canaliculata REUSS, Denkschr. Akad. Wiss. Wien, vol. 7, pt. 1, 1854, p. 70, pl. 26, fig. 4.

Globigerina canaliculata EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 172, pl. 21, figs. 15-17, 24-26.

Test small, the dorsal and ventral faces parallel or even slightly concave, periphery broad and squarely truncate or concave; chambers few, usually 5 in the final whorl, the periphery roughened with short blunt spines, remainder of the surface smooth or slightly spinose in the young; aperture ventral, opening into the umbilical region which is open. Diameter 0.25-0.30 mm.; thickness 0.05-0.08 mm.

Figured specimen from Upper Cretaceous, Pecan Gap Chalk, cut in G. C. and S. F. R. R., at N. edge of Farmersville, Texas, collected by Dr. L. W. Stephenson.

This species is also common in the Mendez Shales of the Tampico Embayment, Mexico.

It is apparently well distributed in the Upper Cretaceous of Europe. Reuss' original figure is less highly ornamented and has more chambers. Our American material is also variable, the particular form here figured being much more nearly like that figured by Egger.

EXPLANATION OF PLATE 22

FIGS. 1 *a, b.* *Glomospira pusilla* (Geinitz). X 75. *a*, side view; *b*, peripheral view.

FIGS. 2 *a, b.* *Ammobaculites compressa* Cushman and Waters, new species. X 50. *a*, side view; *b*, apertural view.

FIGS. 3 *a, b.* *Ammodiscus annularis* (H. B. Brady). X 75. *a*, side view; *b*, peripheral view.

FIG. 4. *Psammophis inversus* Schellwein. X 75.

FIGS. 5, 6. *Turritellella spirans* Cushman and Waters, new species. X 100. *a*, side views; *b*, apertural views. 5, Holotype.

FIGS. 7 *a, b.* *Hyperammina bulbosa* Cushman and Waters, new species. X 75. *a*, front view; *b*, side view.

FIGS. 8 *a, b.* *Endothyra bowmanni* (Phillips). X 75. *a*, side view; *b*, apertural view.

FIGS. 9 *a–c.* *Trochammina rudis* Cushman and Waters, new species. X 75. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

FIGS. 10 *a–c.* *Pulvinulinella interrupta* Cushman, new species. X 50. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

FIG. 11. *Frondicularia tenuissima* Hantken. X 50.

FIGS. 12 *a, b.* *Plectofrondicularia alazanensis* Cushman, new species. X 50. *a*, front view; *b*, end view.

EXPLANATION OF PLATE 23

FIG. 1. *Vulvulina spinosa* Cushman, new species. X 35.

FIG. 2. *Plectofrondicularia trilineata* Cushman, new species. X 50.

FIG. 3. *Plectofrondicularia vaughani* Cushman, new species. X 60.

FIGS. 4 *a–c.* *Globorotalia spinulosa* Cushman, new species. X 80. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

FIGS. 5 *a, b.* *Planulina mexicana* Cushman, new species. X 35. *a, b*, views from opposite sides.

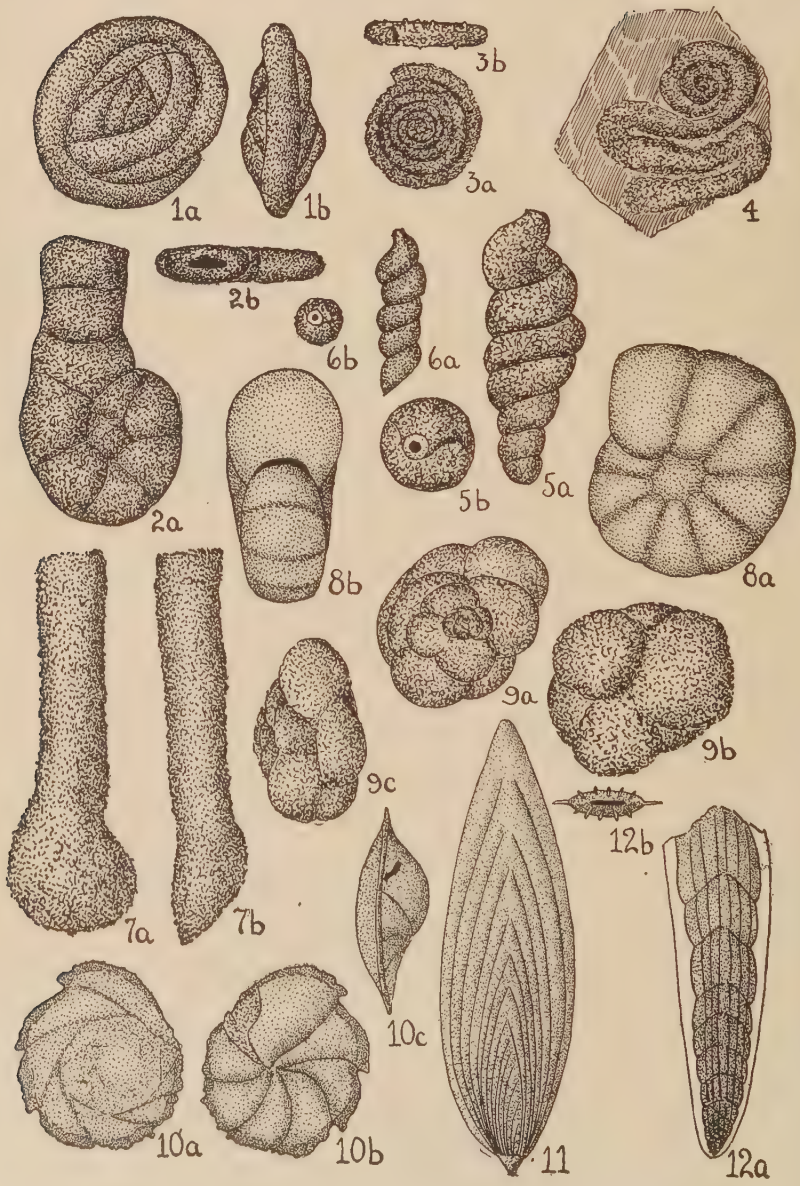
FIGS. 6, 7. *Spiroplectoides rosula* (Ehrenberg). X 80. 6, (After Ehrenberg); 7, Texas specimen.

FIGS. 8 *a, b.* *Pseudouvigerina plummerae* Cushman, new species. X 100. *a*, front view; *b*, apertural view.

FIGS. 9 *a, b.* *Bolivinita planata* Cushman, new species. X 80. *a*, front view; *b*, side view.

FIGS. 10 *a, b.* *Globotruncana calcarata* Cushman, new species. X 80. *a*, dorsal view; *b*, ventral view.

FIGS. 11 *a–c.* *Globotruncana canaliculata* (Reuss). X 80. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.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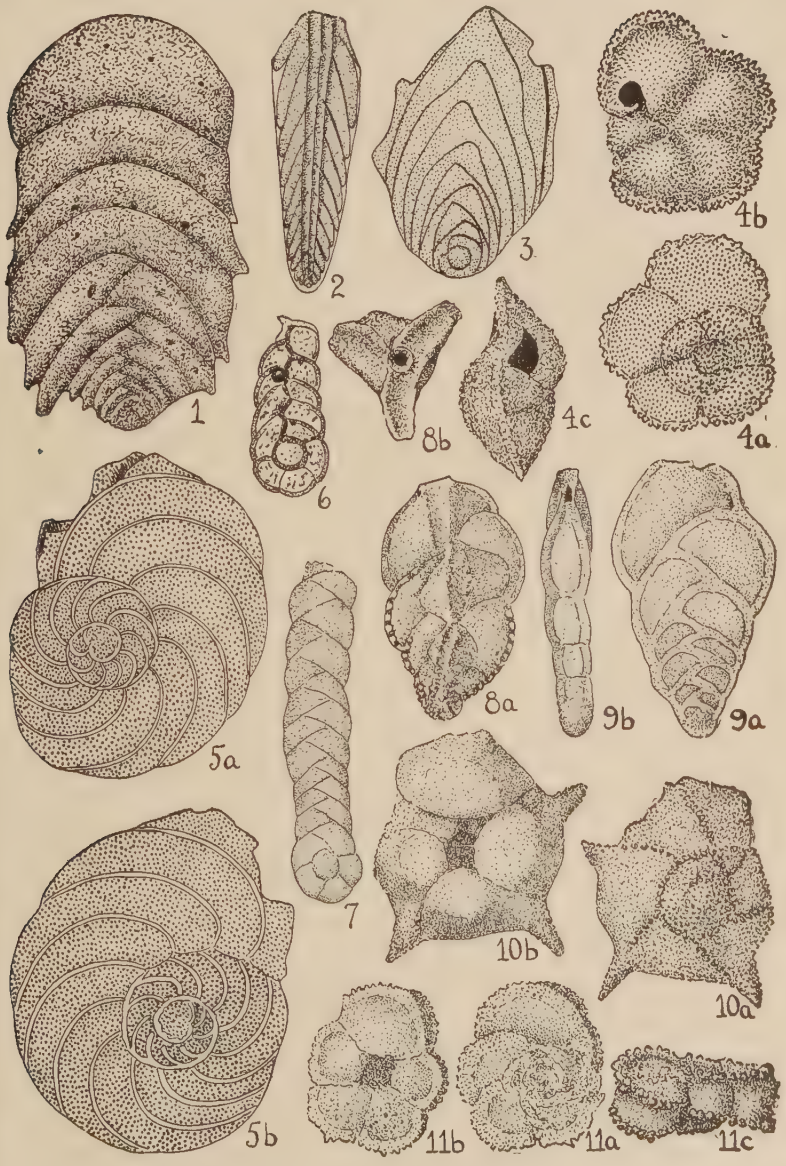
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42. A SPECIES OF SIPHONINELLA IN THE TERTIARY OF AMERICA

By Joseph A. Cushman and Henry V. Howe

The only hitherto known species of *Siphoninella* is *S. soluta* (H. B. Brady) described from a *Challenger* dredging in 390 fathoms off Culebra Island, West Indies. Brady records this as very rare. It is well known that the present foraminiferal fauna of the West Indian region is closely related to that of the Tertiary of the Gulf Coastal Plain of the United States and Mexico, especially to the Oligocene and Upper Eocene. There are many living species which are undoubtedly direct derivatives of closely related Tertiary species.

The finding of a species of *Siphoninella* in the Claiborne of Louisiana, especially in considerable numbers when the only other record for the genus is the rare living West Indian species is interesting. It raises the problem of where the genus has been living during the long interval between these two occurrences. As the single record for the living species is 390 fathoms, it is quite probable that the depth at which it lives is enough to account for this absence in most of the fossil series of the Gulf Coastal Plain, and its occurrence in Louisiana where deposition was naturally in deeper water during the embayment of Claiborne time. The species may be described as follows:

SIPHONINELLA CLAIBORNENSIS Cushman and Howe, new species

Plate 24, figures 8-10

Test in the early portion trochoid, unequally biconvex, the ventral side more convex than the dorsal, in later growth uncoiled in the last two chambers; periphery of the earlier portion strongly carinate, the carina divided into tooth-like portions, usually coalescing and typically with an angle in each process, later chambers slightly rounded and without the keel; sutures somewhat limbate, flush on the dorsal side, very slightly depressed on the ventral; wall very coarsely perforate, especially on the dorsal side; apertural end with a distinct lip, a slightly

constricted neck and narrow elongate aperture.

Length 0.35 mm.; breadth 0.25 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 6711) from Louisiana Oil Refining Co., Tremont No. 1, Township 30, Range 10, 2E, at a depth of 736-740 feet. Paratypes are in the collections of the Louisiana State University and the United States National Museum.

Siphoninella claibornensis differs from *S. soluta* in the periphery which in the fossil species is broad and composed of peculiar tooth-like portions, and in the shape and number of the chambers, fewer and more elongate in the fossil species as well as in the surface which is smooth in the fossil species and in the Recent one with tubercles, especially along the sutures.

43. SOME NOTES ON THE EARLY FORAMINIFERAL GENERA ERECTED BEFORE 1808

By Joseph A. Cushman

It has been puzzling for many of the workers on the foraminifera to know what species should be assigned to some of the early genera. The only hope to understand some of the type species and therefore the genera based on them is a careful study of the type species in European collections. Others are more clearly defined and figured, and the study of material from the exact type locality may be made use of until the actual types have been studied. Nothing however can take the place of actual type specimens which must finally settle all questions as to what the author may have meant by his specific name and therefore of the genus based upon the species. The writer hopes to make a study of many of the older genotypes in European collections this year.

In 1792, Brugiere (Ency. Method., "Vers", vol. 1, 1792, p. 395) described the genus *Camerina* with three new species, *C. laevigata*, *C. nummularia*, and *C. striata*. Of these the first, *Camerina laevigata* Brugiere may be selected as the type. As Lamarck in 1801 used the same species as the type of his genus *Nummulites*, there can be no question but that *Nummulites* is a synonym of *Camerina* Brugiere. Therefore *Camerina* Brugiere, 1792 with its genotype *C. laevigata* Brugiere will stand.

In 1784, Walker and Boys (Testacea minuta rariora, etc.), used the name *Lagena* in a subgeneric sense, but as their work is not binomial, it is ruled out of consideration by the International Rules of Nomenclature. However, in 1798, Walker and Jacob (A Description and Arrangement of Minute and Rare Shells, in Adams' Essays on the Microscope, 2nd Edition) used *Lagena*, and their *Serpula* (*Lagena*) *sulcata*, pl. 14, fig. 5, must be taken as the genotype. This will give as *Lagena*, tests which are single chambered, with a more or less tapering neck, a rounded aperture, wall calcareous and very finely perforate and typically the chamber rounded in transverse section.

In 1801 (Syst. Anim.) and 1804, 1806, and 1807 (Annales du Museum) Lamarck erected numerous genera for foraminifera. During this period however, Montagu in 1803 (Testacea Brit-

annica) used the name *Vermiculum*. I believe no definite species has been selected as the genotype. Of the figured specimens, Plate 14, figure 1 is an obscure form, the generic position of which is very doubtful. Figure 2 is *Vermiculum squamosum* Montagu, a species of British waters. Figure 3 is *V. perlucidum* Montagu, a species well known in the same region. Figure 9 is *V. oblongum* Montagu, the exact character of which is very difficult to determine, a proof of which is the fact that it has been assigned to various genera by later authors. Of the figures, that on plate 14, figure 3, of *Vermiculum perlucidum* Montagu is undoubtedly the most definite, and that species may be taken as the genotype. This would make *Vermiculum* a synonym of *Lagena* Walker and Jacob, and eliminate it from further consideration.

Of the genera erected by Lamarck in 1801, *Nummulites* with the type *Nummulites laevigata* (Brugiere) becomes a direct synonym of *Camerina* Brugiere, 1792, as already noted.

Orbitolites Lamarck, 1801, with its genotype *O. complanata* Lamarck is well known from the Paris Basin Eocene, but as has been shown by later authors must have a more restricted use than has often been made of it. It has the openings between chamberlets of the adjacent preceding and succeeding annuli, but no direct communication between chamberlets of the same annulus.

Siderolites Lamarck, 1801 is also monotypic, the genotype being *S. calcitrapoides* Lamarck from the chalk of Maestricht, Holland. This is a well known species described in detail by many later authors.

Rotalites Lamarck, 1801 had for its type *R. tuberculosa* Lamarck, from Grignon. No figures are given by Lamarck who does refer to some very inadequate figures of Guettard. The description does not give a recognizable conception of what this species may have been. It is not referred to by Lamarck or by later authors, so that it may be identified. The genus *Rotalites* therefore unless the type specimen of *R. tuberculosa* may later be found in Paris and studied, will have to be discarded as unrecognizable.

Oveolites Lamarck, 1801 has been shown to be really a calcareous alga and not a foraminifer, so needs no further consideration here.

Of the genera erected in 1804, *Discorbis* is the first (p. 182). This is a monotypic genus, the genotype being *Discorbis vesicularis* Lamarck (Pl. 24, figs. 1 *a-c*). The type is from Grignon.

It is planoconvex, trochoid, the coils all visible from the dorsal side, only the chambers of the last-formed coil visible from the ventral side, the umbilical region excavated, and the chambers often extending in a narrowed projection across this depressed central area or building up alar projections, the wall calcareous, coarsely perforate, especially on the ventral side, and the aperture a long narrow slit at the base of the chamber extending to the umbilical area, often with a slight lip and often hidden by the basal projection of the chamber. A very similar species often referred to this same specific name is now living in the Australian region, and the genus is well distributed at the present day as well as going well back in the fossil series. d'Orbigny applied the name *Rosalina* to some of the species of *Discorbis*, and many of them are to be found under *Discorbis* in the literature.

Lamarck did not find the aperture in *Discorbis vesicularis*. This is not strange as the covering of the aperture by the alar projections makes it very easily filled with matrix. Many of the younger specimens from Grignon are identical in form and number of chambers with Lamarck's figures. In the adult the number of chambers increases. This is one of the largest, most conspicuous and best characterized species of Grignon.

The genus *Rotalia* Lamarck, 1804 (p. 183), should have chosen as its genotype the first species given by him, *Rotalia trochidiformis* Lamarck (pl. 24, figs. 5-7). This is a very definite species from the Eocene of Grignon. It is planoconvex, dorsal side convex, ventral side flattened, trochoid, ventral side with a solid plug in the umbilical position, the sutures radial and excavated, the sides of the chambers beaded and the whole ventral side usually ornamented with raised papillae, dorsal side smooth, the aperture ventral, along the margin of the last-formed chamber. This is the form to which the name *Rotalia* has usually been applied, and to which d'Orbigny applied other names at different times.

The description of this species especially of the characters of the ventral side is excellent. Plate 24, figs. 7 *a*, *b*, show a young specimen with the lobing of the ventral side; figs. 5 and 6 later stages where the thickening has continued, resulting in the highly ornate ventral side seen in the adult of this species.

Lenticulites Lamarck, 1804, has three species, *L. planulata*, *L. variolaria* and *L. rotulata* Lamarck. The first two of these are not figured, but the last, *L. rotulata* Lamarck, is figured by Lamarck in 1806, Ann. Mus., pl. 62, fig. 11. *Lenticulites rotulata* Lamarck should be taken as the genotype, and is the form usually

referred to as *Cristellaria rotulata* by later authors. This may mean that the generic name *Lenticulites* should be used instead of *Cristellaria* and many of the names given by Montfort. The test is planispiral, involute, biconvex, distinctly umbonate. A study of the type specimen of this species which is in Defrance's collection will give much light on the problem of the generic name to be used for *Cristellaria.*

Lituola Lamarck, 1804, has two species *L. nautiloidea* and *L. difformis* Lamarck of which *L. nautiloidea* Lamarck should be designated as the genotype. It is a test close coiled and involute in the young, uncoiling in the adult, and having several openings in the terminal apertural face. From the description given by Lamarck, the wall may be inferred to be arenaceous and the interior labyrinthic. This agrees well with the restricted use now being made of *Lituola.*

Spirolina Lamarck, 1804, has two species *S. depressa* and *S. cylindracea* Lamarck (pl. 24, fig. 4). The latter being the better known and most common may be chosen as the genotype. The early chambers are planispiral and the later ones in a rectilinear uncoiled series; wall calcareous, imperforate; aperture rounded, terminal. The type of *S. cylindracea* came from Grignon. The genus is represented in the fossil series at least from the Eocene and is widely distributed today in warm, shallow waters.

Miliola Lamarck, 1804, had five species assigned to it by Lamarck as follows: *M. ringens, M. cor-anguinum, M. trigonula, M. planulata,* and *M. saxorum.* The first is now *Biloculina ringens* (Lamarck). *M. trigonula* has been designated as the genotype of d'Orbigny's *Triloculina.*

For *Quinqueloculina, Q. seminulum* (Linné) has already been designated as the type. Of the three original species of Lamarck left, *Miliola saxorum* is the most abundant and best known. As figured by later authors (Terquem, Mém. Soc. géol. France, ser. 3, vol. 2, 1882, pl. 19 (27), figs. 22 *a, b*) the aperture is shown to be cribrate. A study of material from the Eocene of the Paris Basin also shows this character although the plate over the aperture is easily broken and often in poorly preserved specimens not seen. *Miliola saxorum* Lamarck should stand as the genotype of the genus *Miliola* representing those species distinct from *Quinqueloculina* by the cribrate aperture.

Renulina Lamarck, 1804, is a monotypic genus, the genotype being *R. operculariа* Lamarck, fairly common in the Eocene of the Paris Basin at Grignon and elsewhere.

The various species were figured by Lamarck in the Annales du Museum in 1807. The original type specimens when studied will undoubtedly give further light on some of the more obscure species, but the Grignon material while it has more than one faunule can be definitely determined by *Renulina opercularia* and other unmistakable species.

Thus there seem to be well established before the appearance of Montfort's wretchedly illustrated work in 1808 the following definite genera: *Camerina* Brugiere, 1792; *Lagena* Walker and Jacob, 1798; *Orbitolites* Lamarck, 1801; *Siderolites* Lamarck, 1801; *Discorbis* Lamarck, 1804; *Rotalia* Lamarck, 1804; *Lituola* Lamarck, 1804; *Spirolina* Lamarck, 1804; *Miliola* Lamarck, 1804, and *Renulina* Lamarck, 1804. *Lenticulites* Lamarck, 1804, is perhaps less clearly defined than the others, but the type specimen when studied will make clear the now obscure points.

Some of the more important of these species are figured on the accompanying plate that American workers may see to what forms these generic names should be applied.

EXPLANATION OF PLATE 24

FIGS. 1 *a–c*. *Discorbis vesicularis* Lamarck. Adult specimen from the type locality, Grignon, France. *a*, ventral view; *b*, dorsal view; *c*, peripheral view. X 30.

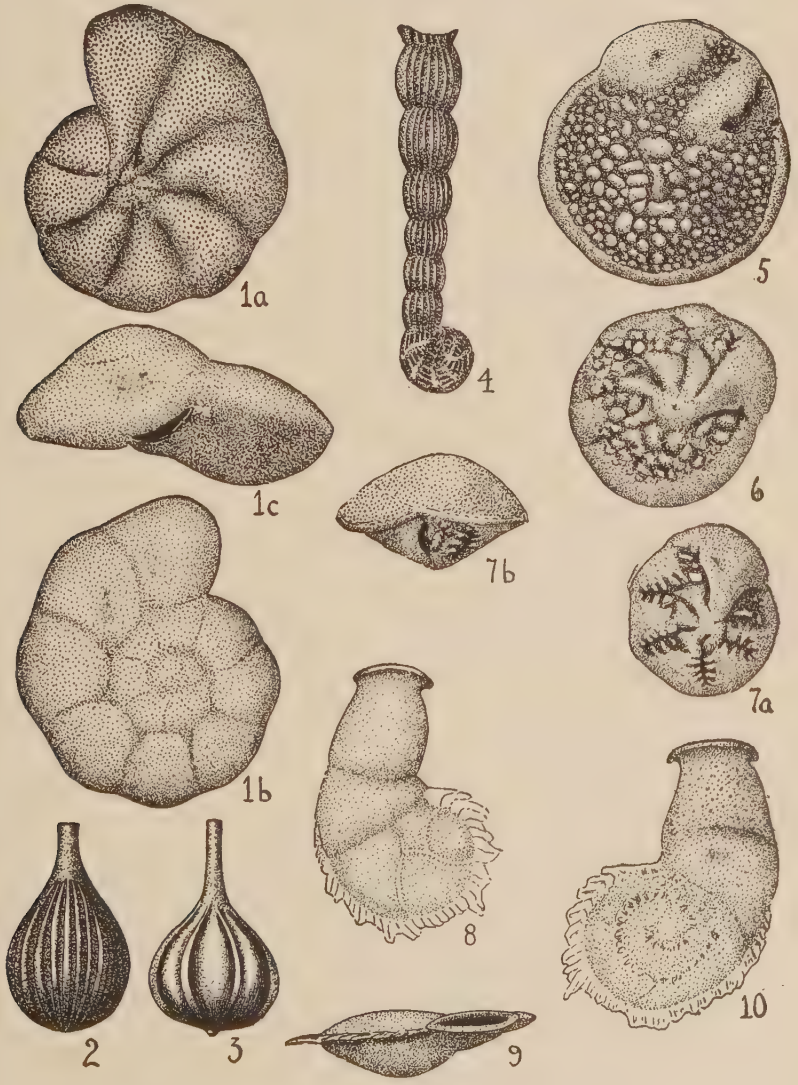
FIG. 2. *Lagena sulcata* Walker and Jacob. After type figure from Walker and Jacob.

FIG. 3. *Lagena perlucida* (Montagu). (*Vermiculum perlucidum*) after type figure of Montagu.

FIG. 4. *Spirolina cylindracea* Lamarck. Specimen from Grignon, France.

FIGS. 5–7. *Rotalia trochidiformis* Lamarck. From the type locality, Grignon, France. X 30. Fig. 5, ventral view of adult showing the characteristic thickenings. Fig. 6, a less mature individual from the ventral side. Fig. 7, a younger specimen showing the start of the ornamentation. *a*, ventral; *b*, peripheral view.

FIGS. 8–10. *Siphoninella claibornensis* Cushman and Howe, n. sp. X 100. Fig. 8, holotype, ventral view. Fig. 9, apertural view. Fig. 10, dorsal view.


1a
1c
1b
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7b
7a
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44. NOTES ON THE GENUS PLEUROSTOMELLA

By Joseph A. Cushman and Reginald W. Harris

The necessity of reviewing the entire literature relating to the genus while working up a collection of recent and fossil species belonging to *Pleurostomella* has made it seem wise to publish brief notes and outline figures for the benefit of other workers. Figures of all but four of the described species are included on Plate 25. Some of these do not belong in the genus as will be indicated in the notes. But a single species was found to be new and this had already been noted by Schubert but no name was given by him. Except for the stippled figures, those on Plate 25 are outlines of the type figures. The species are grouped by geologic periods. Only the original reference is given and no attempt is made to give a complete synonymy.

Genus PLEUROSTOMELLA Reuss, 1860

Nodosaria (part) Reuss, Verst. böhm. Kreid., pt. 1, 1845, p. 28.
Dentalina (part) Reuss, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 24.
Pleurostomella Reuss, (type, *P. subnodosa* (Reuss)), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 203.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 410.—Chapman, The Foraminifera, 1902, p. 174.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 49; Bull. 104, pt. 3, 1922, p. 49; Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, 1927, p. 72.

Test usually elongate, biserial; chambers usually distinct, inflated, the sutures distinct, occasionally somewhat limbate; aperture an arched opening, partially closed by two broad teeth at either side at the base with a narrow slit between.

From the available records, the genus probably arose in the Cretaceous and continues to the present oceans, usually in fairly deep water.

It belongs in the Family Ellipsoidinidae of A. Silvestri, the members of which have a lateral aperture and the interior typically with a tubular structure connecting the chambers. It is thus closely related to the Buliminidae from which the Ellipsoidinidae undoubtedly developed in Cretaceous time. Species of which specimens were studied are indicated by an asterisk.

SPECIES WITH TYPES FROM THE PRESENT OCEANS

**Pleurostomella acuminata* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 50, pl. 19, fig. 6.

Types from Caribbean Sea, *Albatross* H 79 in 821 fathoms (Pl. 25, fig. 1).

Pleurostomella contorta MILLETT, Journ. Roy. Micr. Soc., 1900, p. 280, pl. 2, figs. 11, 12.

Types from Malay Archipelago (Pl. 25, fig. 3).

**Pleurostomella spinosa* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 51, text figs. 3 *a, b.*

Types from *Albatross* D 4970, in 500 fathoms off Japan (Pl. 25, fig. 2).

This species may possibly belong to *Bulimina* as is suggested by its spinose surface. The general structure resembles *Pleurostomella.*

SPECIES WITH TYPES FROM PLEISTOCENE

Pleurostomella sapperi SCHUBERT, Abhandl. Geol. Reichs., vol. 20, pt. 4, 1911, p. 56, text figs. 3 *a, b.*

Type from *Globigerina* earth of Fetsoa, Bismarck Archipelago (Pl. 25, fig. 4).

This is one of the very few ornamented species.

**Pleurostomella* sp. nov. SCHUBERT, Abhandl. Geol. Reichs., vol. 20, pt. 4, 1911, p. 57, text figs. 4 *a, b.*=*P. schuberti* CUSHMAN and HARRIS, n. sp. See below.

Schubert's specimens are from the Bismarck Archipelago (Pl. 25, fig. 5).

SPECIES WITH TYPES FROM THE PLIOCENE

**Pleurostomella alternans* SCHWAGER, *Novara*-Exped., Geol. Theil., pt. 2, 1866, p. 239, pl. 6, figs. 79, 80.

Types from Kar Nicobar (Pl. 25, figs. 7, 8).

This species has been widely recorded. We have specimens which seem to be identical with this species from the Pliocene of the Sepik River, New Guinea. In the Eocene of Mexico and Trinidad specimens occur which very closely resemble this species, and one of these is figured (Pl. 25, fig. 28).

Pleurostomella brevis SCHWAGER, *Novara*-Exped., Geol. Theil., pt. 2, 1866, p. 239, pl. 6, fig. 81.

Types from Kar Nicobar (Pl. 25, fig. 6).

SPECIES WITH TYPES FROM THE MIOCENE

Pleurostomella alternans SCHWAGER, var. *telostoma* SCHUBERT, Sitz. deutsch. naturwiss.-med. Ver. Böhmen "Lotos", vol. 20, 1900, p. 224, pl. 5, figs. 5 *a, b.*

Types from Karwin, Austria (Pl. 25, fig. 9).

This and related forms represent a stage seen in a number of species of the genus where in the adult a small partially developed chamber ends the development. In such forms there is a tendency for the aperture to become terminal.

Pleurostomella alternans SCHWAGER, var. *parvifinita* SCHUBERT, Sitz. deutsch. naturwiss.-med. Ver. Böhmen "Lotos", vol. 20, 1900, p. 224, pl. 5, figs. 6 *a-c.*

Types from Karwin, Austria (Pl. 25, fig. 10).

Pleurostomella alternans SCHWAGER, var. *moravica* SCHUBERT, Sitz. deutsch. Naturwiss.-med. Ver. Böhmen "Lotos", vol. 20, 1900, p. 157, pl. 2, fig. 5.

Types from Ptin, Austria (Pl. 25, fig. 11).

This is another of the varieties with a subterminal aperture.

Pleurostomella alternans SCHWAGER, var. *hians* SCHUBERT, Jahrb. Geol. Reichsanst, vol. 52, 1903, p. 297.

Types from Karwin, Austria (Pl. 25, fig. 12).

Pleurostomella pleurostomella (A. SILVESTRI). *Ellipsopleurostomella pleurostomella* A. SILVESTRI, Accad. Real. Sci. Torino, 1903-04, p. 7, text figs. 4, 5.

Types from the Piedmont, Italy (Pl. 25, fig. 13).

This differs from *Pleurostomella subnodosa* in the amount of enveloping of the chambers and in the broader aperture.

SPECIES WITH TYPES FROM THE EOCENE

**Pleurostomella alazanensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 5, pl. 1, figs. 2 *a, b.*

Types from Alazan Clay, 2½ kms. S. W. of Carrizo on Rio Tamuin, San Luis Potosi, Mexico (Pl. 25, fig. 21).

Pleurostomella acuta HANTKEN, A magy. kir. földt. int. evkönyve, vol. 4, 1875 (1876), p. 37, pl. 13, fig. 18.

Types from *Clavulina*-Szaboi beds of Hungary (Pl. 25, fig. 14).

Pleurostomella eocaena GÜMBEL, Abhandl. kön. bay. Akad. Wiss., München, vol. 10, 1868, p. 630, pl. 1, figs. 53 *a, b.*

Types from Gotzreuther in the Bavarian Alps (Pl. 25, fig. 15).

This species is characterized by its small size and abnormally large final chamber, a character which seems suspiciously like

an individual abnormality. Hantken figures a specimen as *P. eocaena*, A. magy. kir. földt. int. evkönyve, vol. 4, 1875 (1876), pl. 13, fig. 17, which is a different thing and is close to the Trinidad and Mexican specimens referred to *P. alternans* SCHWAGER.

Pleurostomella rapa GÜMBEL, Abhandl. kön. bay. Akad. Wiss., München, vol. 10, 1868, p. 630, pl. 1, figs. 53 *a, b*.

Types from Gotzreuther, Bavarian Alps (Pl. 25, fig. 18).

Pleurostomella jacksonensis CUSHMAN and APPLIN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 168, pl. 7, figs. 9 *a-c*.

Types from Haynes Well No. 1, 3175-3270 feet, near Burkville, Newton Co., Texas (Pl. 25, fig. 17).

This is one of the few ornamented species of the genus.

Pleurostomella bellardi HANTKEN, Ertek. termesz. kör., vol. 13, 1883, p. 25, pl. 2, figs. 1 *a, b*.

Types from the Eocene of Hungary. This and the two following species are not figured on the plate.

Pleurostomella incrassata HANTKEN, Ertek. termesz. kör., vol. 13, 1883, p. 25, pl. 1, figs. 4 *a, b*; 7 *a, b*.

Types from the Eocene of Hungary.

Pleurostomella tenuis HANTKEN, Ertek. termesz. kör., vol. 13, 1883, p. 25, pl. 1, figs. 5 *a, b*.

Types from the Eocene of Hungary.

SPECIES WITH TYPES FROM THE CRETACEOUS

**Pleurostomella subnodosa* REUSS (Genotype), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 204, pl. 8, figs. 2 *a, b*.

Types from Westphalia, Germany (Pl. 25, fig. 23).

We have had American specimens from Navarro formation, branch of Kickapoo Creek, 1200′ S. of Public Road, 1.8 miles N. W. of Annona, Red River Co., Texas, and from Pecan Gap Chalk, Greenville Road, 5.1 miles S. by W. of Wolfe City, Texas, collected by L. W. Stephenson.

Pleurostomella barroisi BERTHELIN, Mém. Soc. Géol. France, ser. 3, vol. 1, 1880, p. 30, pl. 1 (24), figs. 13 *a, b*.

Types from the Albien at Moncley, France (Pl. 25, fig. 24).

This seems more like a *Nodosarella* than a *Pleurostomella*.

Pleurostomella obtusa BERTHELIN, Mém. Soc. Géol. France, ser. 3, vol. 1, 1880, p. 29, pl. 1 (24), figs. 9 *a, b*.

Types from the Albien at Moncley, France (Pl. 25, fig. 22).

Pleurostomella reussi BERTHELIN, Mém. Soc. Géol. France, ser. 3, vol. 1, 1880, p. 25, pl. 1 (24), figs. 10-12.

Types from the Albien at Moncley, France (Pl. 25, fig. 25).

Pleurostomella fusiformis REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 205, pl. 8, fig. 1.

Types from Westphalia, Germany (Pl. 25, fig. 21').

This species from the figure is not characteristically a *Pleurostomella,* the alternating character of the chambers being almost obsolete and taking on the characters of *Nodosarella.*

**Pleurostomella torta* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, 1926, p. 18, pl. 2, fig. 7.

Types from east of Pujal, San Luis Potosi, Mexico (Pl. 25, fig. 16).

**Pleurostomella clavata* CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 590, pl. 16, figs. 5 *a, b.*

Types from Velasco shale, near Velasco, Mexico (Pl. 25, fig. 19).

**Pleurostomella velascoensis* CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 590, pl. 16, figs. 4 *a, b.*

Types from Velasco shale, near Velasco, Mexico (Pl. 25, fig. 20).

Pleurostomella globulifera FRANKE, Verhandl. Nat. Hist. Ver., vol. 59, 1912 (1913), p. 265, pl. 6, fig. 3.

Types from near Ahlen, Germany. This is in reality an *Ellipsoglandulina.* It is not figured on our plate.

SPECIES WITH TYPES FROM THE JURASSIC

Pleurostomella jurassica HAEUSLER, Abhandl. Schweiz. Pal. Ges., vol. 17, 1890, p. 77, pl. 12, figs. 14-22.

Types from the Transversarius zone of Switzerland (Pl. 25, figs. 30-32).

These are arenaceous forms and do not belong with *Pleurostomella.* The aperture is not that of this genus.

SPECIES WITH TYPES FROM THE PERMO-CARBONIFEROUS

Pleurostomella antiqua CHAPMAN, Mem. Geol. Survey, New South Wales, vol. 14, 1905, p. 14, pl. 2, fig. 5.

Types from Wollong, New South Wales (Pl. 25, fig. 27).

There is little about the figure to suggest *Pleurostomella,* and it may be questioned if it really belongs here.

The following species is new:

PLEUROSTOMELLA SCHUBERTI Cushman and Harris, n. sp.

Plate 25, figures 29 *a, b*

Pleurostomella n. sp., SCHUBERT, Abhandl. Geol. Reichs., vol. 20, pt. 4, 1911, p. 57, text figs. 4 *a, b*.

Test elongate, somewhat compressed, slightly tapering in side view, in front view narrow, the sides nearly parallel; chambers few, elongate, apertural end of the last-formed chamber extended and somewhat spatula-formed; sutures distinct, very slightly depressed, slightly limbate; wall smooth, finely perforate; aperture broadly elliptical, teeth not apparent.

Length 0.65 mm.; breadth 0.13 mm.; thickness 0.10 mm.

Holotype (U. S. Nat. Mus. No. 20308) from *Albatross* D 5348, Palawan Passage, Philippines, 375 fathoms.

This is evidently the same as the species figured but not named by Schubert in the above reference. With the closely related *P. sapperi* Schubert it is unique in the genus in the character of the very strong lateral compression.

EXPLANATION OF PLATE 25

FIG. 1. *Pleurostomella acuminata* Cushman. (After Cushman, 1922.)
FIG. 2. *Pleurostomella spinosa* Cushman. (After Cushman, 1911.)
FIG. 3. *Pleurostomella contorta* Millett. (After Millett, 1900.)
FIG. 4. *Pleurostomella sapperi* Schubert. (After Schubert, 1911.)
FIG. 5. *Pleurostomella* sp. nov. Schubert. (After Schubert, 1911.)
FIG. 6. *Pleurostomella brevis* Schwager. (After Schwager, 1866.)
FIGS. 7, 8. *Pleurostomella alternans* Schwager. (After Schwager, 1866.)
FIG. 9. *Pleurostomella alternans* Schwager, var. *telostoma* Schubert. (After Schubert, 1900.)
FIG. 10. *Pleurostomella alternans* Schwager, var. *parvifinita* Schubert. (After Schubert, 1899.)
FIG. 11. *Pleurostomella alternans* Schwager, var. *moravica* Schubert. (After Schubert, 1899.)
FIG. 12. *Pleurostomella alternans* Schwager, var. *hians* Schubert. (After Schubert, 1903.)
FIG. 13. *Pleurostomella pleurostomella* (A. Silvestri). (After A. Silvestri, 1904.)
FIG. 14. *Pleurostomella acuta* Hantken. (After Hantken, 1875.)
FIG. 15. *Pleurostomella eocaena* Gümbel. (After Gümbel, 1868.)
FIG. 16. *Pleurostomella torta* Cushman. (After Cushman, 1926.)
FIG. 17. *Pleurostomella jacksonensis* Cushman and Applin. (After Cushman and Applin, 1926.)
FIG. 18. *Pleurostomella rapa* Gümbel. (After Gümbel, 1868.)
FIG. 19. *Pleurostomella clavata* Cushman. (After Cushman, 1926.)
FIG. 20. *Pleurostomella velascoensis* Cushman. (After Cushman, 1926.)
FIG. 21. *Pleurostomella alazanensis* Cushman. (After Cushman, 1925.)
FIG. 21′. *Pleurostomella fusiformis* Reuss. (After Reuss, 1860.)
FIG. 22. *Pleurostomella obtusa* Berthelin. (After Berthelin, 1880.)
FIG. 23. *Pleurostomella subnodosa* Reuss. (After Reuss, 1860.)
FIG. 24. *Pleurostomella barroisi* Berthelin. (After Berthelin, 1880.)
FIG. 25. *Pleurostomella reussi* Berthelin. (After Berthelin, 1880.)
FIG. 26. *Pleurostomella subnodosa* Reuss. Texas specimen.
FIG. 27. *Pleurostomella antiqua* Chapman. (After Chapman.)
FIG. 28. *Pleurostomella alternans* Schwager. Specimen from Trinidad.
FIG. 29. *Pleurostomella schuberti* Cushman and Harris, n. sp. Philippine specimen.
FIGS. 30–32. *Pleurostomella jurassica* Haeusler. (After Haeusler.)


1
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2b
2c
3a
3b
3c
4a
4b
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5b
6a
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7a
7b
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9a
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23a
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24a
24b
25
25b
25c
26a
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28a
28b
29a
29b
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32

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

Chapman, Frederick and Walter James Parr.
Tertiary Foraminifera of Victoria, Australia. The Balcombian deposits of Port Phillip. Part II.
(Journ. Linn. Soc. Zool. London, vol. 36, 1926, pp. 373-399, 5 pls.)
Melbourne.

This is the second part of this paper, the first of which was published in 1907. This second part takes up 86 species and varieties of the Lagenidae, of which one species and variety are described as new.

Matley, C. A. and A. Morley Davis.
Some Observations on the Geology of Viti Levu.
(Geol. Mag., vol. 64, 1927, pp. 65-75, 3 text figs.)
London.

Mention of several foraminiferal genera is made, and something of their occurrence in the deposits given.

Cushman, Joseph A.
Foraminifera of the Genus Ehrenbergina and its Species.
(Proc. U. S. Nat. Mus., vol. 70, 1927, pp. 1-8, 2 pls.)
Washington.

A review of the species of this genus, figures after the originals and the distribution is given. One new species is described.

Nuttall, W. L. F.
The localities whence the Foraminifera figured in the report of H. M. S. "Challenger" by Brady were derived.
(Ann. Mag. Nat. Hist., ser. 9, vol. 19, 1927, pp. 209-241.)
London.

A very valuable work giving the localities of the figured specimens of Brady's work as well as the place of deposit of the type specimens.

Vaughan, T. Wayland.
Species of *Lepidocyclina* and *Carpenteria* from the Cayman Islands.
(Quart. Journ. Geol. Soc., vol. 82, Oct. 1926, pp. 388-400, 3 plates.)
London.
Notes are given on the preparation of sections for both field and laboratory use. Copious notes are given on several species and are illustrated by excellent photographs of sections. One new variety is described.

Vaughan, T. Wayland.
The Stratigraphic Horizon of the Beds Containing *Lepidocyclina chaperi* on Haut Chagres, Panama.
(Proc. Nat. Acad. Sci., vol. 12, No. 8, Aug. 1926, pp. 519-522.)
Washington.
Notes are given on the various species occurring at this locality and something of their distribution.

Vaughan, T. Wayland.
Foraminifera from the Upper Eocene Deposits of the Coast of Ecuador.
(Proc. Nat. Acad. Sci., vol. 12, No. 8, Aug. 1926, pp. 533-535.)
Washington.
Notes are given on several genera found in the collection from the locality given.

Silvestri, A.
Pseudonummuliti nel Terziario della Toscana.
(Atti Pont. Accad. Sci. Nuovi Lincei, Anno 79, 1926, pp. 155-159, text figs.)
Rome.
Figures of these bodies which externally resemble Nummulites are given and notes on their structure.

Silvestri, A.
Rinvernimento di "Dictyoconus" nell'Eocene delle Isole Ionie.
(Mem. Pont. Accad. Sci. Nuovi Lincei, vol. 9, 1926, pp. 1-8, 1 plate.)
Rome.

Figures of a number of the conical-shaped genera are given with notes on their structure and stratigraphic distribution.

Yabe, Hisakatsu and Shoshiro Hanzawa.
Globigerina Ooze from the Sea lying South of Okinawa-jima (the Riukiu Islands).
(Jap. Journ. Geol. Geog., vol. 4, 1925 (1926), pp. 47-54, 1 fig.)
Tokio.

This paper gives the results in tabular form of the examination of nine samples from the above region.

Hanzawa, Shoshiro.
Globigerina-marl and Other Foraminiferous Rocks underlying the Raised Coral Reef Formation of Okinawa-jima (The Riukiu Islands).
(Jap. Journ. Geol. Geog., vol. 4, 1925 (1926), pp. 33-45.)
Tokio.

A list of 254 species and varieties of foraminifera is given with their frequency at a number of stations.

Cushman, Joseph A.
Some Palaeontologic Evidence Bearing on a Classification of the Foraminifera.
(Amer. Journ. Sci., vol. 13, Jan. 1927, pp. 53-56.)
New Haven.

A review of the evidence, especially from the Palaeozoic, of what is primitive in the Foraminifera, and its bearing on classification is given.

Cushman, Joseph A.
Phylogenetic Studies of the Foraminifera. Part I.
(Amer. Journ. Sci., vol. 13, April 1927, pp. 315-326, text figures.)
New Haven.

The lines of development as shown in the Buliminidae and Heterohelicidae are discussed, and the abundance of parallelisms shown.

Cushman, Joseph A.
The Occurrence of *Lituonella* and *Coskinolina* in America.
(Journ. Washington Acad. Sci., vol. 17, No. 8, April 1927, pp. 198, 199.)
Washington.

These two genera occur in the Middle Eocene of Florida with a number of others which show the correlation in age between these beds and those of Southern Europe.

Hanna, G. Dallas.
The Photography of Small Objects.
(Trans. Amer. Micr. Soc., vol. 46, Jan. 1927, pp. 15-25.)
New York.

The mathematical side of the photography of foraminifera and other micro-organisms is carefully worked out, and the possibilities and limits of direct photography shown.

Hanna, Marcus A.
Separation of Fossils and Other Light Materials by Means of Heavy Liquids.
(Economic Geol., vol. 2, 1927, pp. 14-17.)
Lancaster.

The use of heavy liquids especially bromoform is described, and the application to foraminifera and other objects discussed.

Tobler, Aug.
Über *Cyclammina* (*Choffatella*) *sequana* Merian spec.
(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 19, 1926, pp. 714-719, 1 plate.)
Basel.

Notes are given on the occurrences and earlier references to this and related forms, and a new name proposed.

Tobler, Aug.
Miogypsina im untersten Neogen von Trinidad und Borneo.
(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 19, 1926, pp. 719-722.)
Basel.

A discussion of the occurrences and relationships of this genus in the two regions is discussed.

Tobler, Aug.
Meandropsina im Tertiär von Ostborneo.
(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 20, 1927, pp. 321-323, 1 plate.)
Basel.

The occurrence is discussed and the species illustrated from photographs.

Tobler, Aug.

Verkalkung der Lateral-Kammern bei *Miogypsina*.

(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 20, 1927, pp. 323-330, 5 text figures.)

Basel.

Two new species are described and illustrated by sections.

Cushman, Joseph A. and G. Dallas Hanna.

Foraminifera from the Eocene Near Coalinga, California.

(Proc. Calif. Acad. Sci., ser. 4, vol. 16, April 22, 1927, pp. 205-229, pls. 13, 14.)

San Francisco.

Thirty-three species and varieties are recorded with nine of them new.

Heron-Allen, E. and A. Earland.

Report on the Foraminifera of the Cambridge Expedition to the Suez Canal.

(Trans. Zool. Soc. London, vol. 22, Part 1, No. 9, December 1926, pp. 65-70.)

London.

A report on material from nine stations with notes, and a list of species with distribution.

J. A. C.

CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

VOLUME 3, PART 3, SEPTEMBER, 1927

45. NOTES ON THE COLLECTION OF DEFRANCE

By Joseph A. Cushman

The original collection of Defrance is a very important one from the point of view of knowing clearly the species which have become genotypes. I am greatly indebted to Dr. Ferdinand Canu and Dr. Henri Douvillé for the information that this collection is preserved in the Museum of the University at Caen. Doctor Canu kindly accompanied me to Caen for a two days' trip and Professor A. Bigot at Caen gave me every facility for the study of the collection.

The specimens were originally mounted on strips of gray pasteboard with the original labels on the front, and on the back are Lamarck's original labels carefully pasted on the strip. Each strip of cardboard is in a large glass tube. Very few of the original specimens on the slides are missing or damaged which is a great credit to those who have had the collection in charge for more than a hundred years.

The first and perhaps the most important part of the Defrance collection is that which was described by Lamarck in 1804 (Annales du Museum, vol. 5 and figured in vol. 8). Nearly all the species described by Lamarck in his paper are given as in "Cabinet de M. Defrance." I have already given some notes on these species (Contr. Cushman Lab. Foram. Research, vol. 3, pt. 2, pp. 123-126). It is now possible to enlarge upon and confirm the points made in that paper.

Discorbis vesicularis Lamarck. There are 17 specimens on the slide all of the same species already well known from the figures of many authors and the same that I have figured (l. c. pl. 24, figs. 1 *a-c*). This species is then the genotype of *Discorbis* which is a very excellent genus. The species is fairly common at the type locality, Grignon, where I collected excellent material through the kindness of Prof. Courtreur.

Rotalia trochidiformis Lamarck. The type slide from Grignon has 30 specimens all of the same species which is the genotype of *Rotalia*. They are of the same features as the series I have figured (l. c. pl. 24, figs. 5-7) and identical with others which have been figured from the Eocene of France, as by Terquem in 1881, whose figured specimens I examined through the courtesy of Dr. Douvillé and Dr. G. Dollfus.

The types of *Rotalia lenticulina* Lamarck, *R. depressa* Lamarck, and *R. discorbula* Lamarck were also examined. The last is the large strongly biconvex species that occurs at Grignon but is smooth and very different from *R. trochidiformis*. The other two species were not figured by Lamarck, and a study of the published material will be necessary to place them in their correct position. *Rotalia depressa* Lamarck is the *Rosalina parisiensis* of d'Orbigny, *Discorbis parisiensis* (d'Orbigny), under which it must be placed as a nomen nudum.

As I have already indicated (l. c. p. 124) *Lenticulina rotulata* Lamarck is the genotype of *Lenticulina*. The type slide has three specimens from the White Chalk of Meudon. The central one of the three is the best preserved, and is a typical keeled *"Cristellaria."* A sketch of this specimen is given here, pl. 28, fig. 7. The aperture is radiate and there is no supplemental median aperture as in *"Robulus."* The keel is sharp and well marked, the apertural face somewhat thickened at the sides as in so many species of *"Cristellaria,"* the test is umbonate as in the earlier conception of this species by many authors. There can be no question but that Lamarck's *Lenticulina rotulata* is a well characterized species of what has been called *"Cristellaria,"* and by the rules of priority must stand for that genus instead of *Cristellaria* Lamarck, 1816 or any of the sixteen generic names proposed by Montfort in 1808. The other two species of the genus not figured by Lamarck are *"Nummulites."*

Lituola nautiloidea Lamarck is also from Meudon. There are 14 specimens on the slide, one very large, the holotype, figured by Lamarck. The early portion is close coiled and the last three chambers uncoil. The aperture is multiple and terminal in the adult and even in the later portion of the coiled adult the apertures are multiple as shown in the sketches (pl. 28, figs. 8, 9).

As shown by the excellent sections on the slide the aperture in the young is simple, at the base of the apertural face as in *Haplophragmoides*. The test is made of white agglutinated material with a fairly smooth surface, easily eroded and showing the rough character of the structure of the wall. The in-

terior is not labyrinthic, and it is probable that *Lituola* will include those Cretaceous species which were referred to *Haplophragmium* by Reuss. *Lituola difformis* also from Meudon has 11 specimens on its type slide, some of which are sections. It is very globular, with 5 or 6 chambers in the coil, the last of which starts to uncoil. The surface is also smoother than in *L. nautiloidea*.

Spirolina cylindracea Lamarck from Grignon is well marked, and has already been referred to (l. c. p. 125). The type slide has 29 specimens all of this same species, which has usually been referred to as "*Peneroplis cylindracea*." Var. β however is represented by a slide with 16 specimens which are *Clavulina*. *Spirolina depressa* Lamarck is well known at Grignon. There are 26 specimens on the slide and 37 specimens on the slide of the variety unnamed by Lamarck but which is a smaller form starting to uncoil.

Miliola ringens Lamarck is the only one of the series not in the collection. It is the genotype of *Biloculina* d'Orbigny, but which is preoccupied by *Pyrgo* Defrance as will be noted later.

Miliola cor-anguinum Lamarck with 14 specimens from Grignon is a *Triloculina* very close to the following species but more rounded and inflated.

Miliola trigonula Lamarck with 15 specimens and traces of 3 others on the slide is the genotype of *Triloculina*. It has curved sides, the angles rounded and a slightly bifid tooth.

Miliola planulata Lamarck from Louvres has 4 specimens. They are quinqueloculine, the chambers smooth and rounded, and the sutures very slightly depressed. It probably belongs under *Quinqueloculina*, although there is a tendency toward *Massilina*. Var. β and γ are other things which will be noted at a later time.

Miliola saxorum Lamarck is from "Mont-Rouge prés Paris, et ailleurs dan les pierres." There is no slide from Mont-Rouge which is evidently in Lamarck's collection. There is however a slide from Grignon on which are two species, one of which is the elongate form already referred to (l. c. p. 125) with its ornamentation consisting of pits arranged in longitudinal lines. The aperture in well preserved specimens has a cribrate plate although this is delicate and easily lost.

Miliola opposita Lamarck is from Grignon and has 7 specimens on the slide. The specimens are deeply and strongly costate. The text reads "prés Pontois." A section is necessary to

determine whether this species should be assigned to *Spiroloculina* or *Massilina.*

Miliola birostris Lamarck has a slide with 3 specimens from Chaumont. It was not figured by Lamarck. It is a very elongate, narrow species, smooth or very finely striate.

Renulina opercularia Lamarck has 23 specimens on the type slide from Grignon. The specimens are all typical. This is a rare genus but was splendidly developed in the Lutetian of Grignon.

There are also in the Defrance collection at Caen certain of the species described in 1820 and 1824 by Defrance which are worthy of mention.

Fabularia sphaeroidinalis Defrance from the Lutetian of Chaumont with 9 complete or fragmentary specimens on the slide. Like *F. discolithus* Defrance (*F. ovata* DeRoissy) the test is very similar to *"Biloculina"* with the interior of the chambers labyrinthic. The genus is distinct from *"Biloculina,"* and is a specialized one of this part of the Eocene.

Frondicularia complanata Defrance has 3 specimens on the type slide labelled "Rimini," Italy. The middle specimen is very large and is apparently the specimen figured by Defrance. It is megalospheric with a swollen proloculum which is elongate and costate, the border at the base is nearly horizontal, with spinose projections. The other complete specimen has a smaller proloculum, is more angled at the base, and the costae appear on the basal edges of other chambers adjacent to the proloculum. In these evidently megalospheric specimens there is no sign of coiling although it does occur in the microspheric specimens. I obtained this species in my own collecting at Rimini, the type locality. A study of these specimens shows that not all of the forms assigned to *Frondicularia complanata* are the same as Defrance's species.

Planularia auris Defrance is the genotype of *Planularia.* There are 5 specimens on the type slide labelled "Rimini, Italie." The specimens show the characters much more clearly than the figure. The species is a flattened *"Cristellaria"* the chambers extending to the base on one side, the other side a nearly straight line. The dorsal or straight edge is sharply keeled with another keel at either side. On the flattened sides near the base are a few slightly developed costae running across the sutures. The sutures themselves are of clear material and very distinct. *Planularia* may perhaps be used in a subgeneric sense to take those species of *"Cristellaria"* which are much compressed, with

flattened sides and approach *Vaginulina* in the character of having one straight side.

I collected beautiful specimens of this species at the type locality, Rimini, and a study of these with the types shows that there is a rounded aperture below the radiate one at the angle and thus shows its relationship to *Robulina*.

Pyrgo laevis Defrance is the genotype of *Pyrgo*. There are 6 specimens on the slide, one very large one evidently that figured by Defrance. The type slide is marked "Italie." These are all "Biloculinas" with a broad aperture. Specimens very close to the types are in the material I collected both from Rimini and Coroncina. There has been some question in regard to the status of *Pyrgo* as it has been referred by some of the authors to the Pteropods. A study of the type slide is sufficient to show that it is unquestionably a "*Biloculina*."

With this point definitely settled, it seems that there is no alternative under the rules of nomenclature but to substitute the use of *Pyrgo* Defrance 1824 for that of *Biloculina* d'Orbigny 1826. This is somewhat of a pity as the names *Quinqueloculina*, *Triloculina*, and *Biloculina* are very expressive of the structural characters of these three genera. The two earlier names may be retained however. d'Orbigny uses the specific name *Biloculina laevis* Defrance and places *Pyrgo* as a synonym. The chain of evidence for the use of *Pyrgo* Defrance therefore seems complete.

Saracenaria italica Defrance is the genotype of *Saracenaria*. The type slide has 5 specimens and is marked "Pliocene, Italie." I collected it at Coroncina and also on the coast of the Adriatic at Rimini. It is very evident that not all of the material referred to this species by various authors belongs here.

Textularia sagittula Defrance is the genotype of *Textularia*. Very many things have been referred to this species. It is abundant in the Pliocene of Coroncina, Italy. It is a small species with acute angles and not at all like many of the figures referred to it.

There are a number of other species in the Defrance collection but the notes already given refer to those species which through the work of Lamarck and Defrance based on this collection have become genotypes. The study of these types has shown definitely what these two authors had when they wrote their descriptions and drew their figures. The three localities of Grignon, Rimini, and Coroncina have become classic through their work coupled with that of Soldani and later authors.

46. ARENACEOUS PALAEOZOIC FORAMINIFERA FROM TEXAS

By Joseph A. Cushman and James A. Waters

The foraminiferal fauna of the Pennsylvanian and Permian of Texas, Oklahoma and Kansas is probably richer in species and individuals than formations of the same age in other parts of the world. Conditions at the time of deposition were often changing rapidly and for this reason probably the fauna is more varied and forms are more abundant than in regions where conditions were more uniform over long periods of time.

The fauna almost entirely consists of arenaceous forms, often primitive in character. Some of the species are of unusual interest in the light they throw upon lines of development in the arenaceous foraminifera. A number of genera which were known to be primitive in character have in the last year been recorded from the Pennsylvanian of America, and the evidence of the fossil record is added to that of development and morphology. Notes on some of the more interesting species follow:

HYPERAMMINA GLABRA Cushman and Waters, n. sp.
Plate 26, figure 1

Test elongate, consisting of an oval proloculum and an elongate tubular second chamber, tapering from the narrowest diameter near the proloculum to the greatest width near the apertural end; wall of fine arenaceous material with much cement; aperture formed by the open end of the tube. Length of holotype 1.35 mm.; greatest diameter 0.20 mm.; diameter of proloculum 0.15 mm.

Holotype (Cushman Coll. No. 7003) from 25 feet below the Palopinto limestone near top of Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

This species may be distinguished by the somewhat tapering form of the second chamber and the large proportion of cement in the wall of the test. The tapering shape of the test near the aperture in the figured specimen is somewhat accentuated by a slight compression of the test at that point, but without this there is a decided tapering of the test toward the aperture.

NODOSINELLA ARENATA Cushman and Waters, n. sp.
Plate 26, figures 2 *a*, *b*; 3

Test longer than broad, composed of a few, two to four, chambers, each rounded in transverse section, slightly longer than broad, the apertural end tapering; sutures deep; wall of coarsely arenaceous particles but with much cement; apertural end of the chamber produced, with a slight neck, aperture circular, large. Length of holotype 1.25 mm.; breadth 0.80 mm.

Holotype (Cushman Coll. No. 7004) from the Mineral Wells division of the Upper Strawn formation, 4.5 miles S. W. of Mineral Wells, on Palopinto road, Palopinto Co., Texas.

There is a large amount of cement but on the rounded portions of the test the dark arenaceous fragments show through conspicuously. The aperture is large with an elongation of the chamber. Many of the specimens are crushed, but enough are well preserved to show the full characters of the species.

NODOSINELLA GLABRA Cushman and Waters, n. sp.
Plate 26, figures 4, 5 *a*, *b*

Test slender, tapering, the initial end occasionally slightly curved; chambers somewhat irregular, numerous; sutures not deeply depressed, indistinct; wall finely arenaceous with a large proportion of cement; apertural end the widest part of the test, aperture small, circular, terminal. Length of holotype 0.75 mm.; breadth 17 mm.

Holotype (Cushman Coll. No. 7006) from 6 inches below Gunsight limestone at Graham, Young Co., Texas.

This is a slender, small, but distinctive species, the sutures not depressed but fairly well shown, the wall very finely arenaceous with much cement. The apertural end is apparently broad, but this is probably due to the breaking of the test due to weakness along the suture, as in all the specimens examined there is a small circular aperture slightly below the level of the end of the test, appearing as though it were the aperture of the previous chamber, rather than a final one.

GLOMOSPIRA DUPLEX Cushman and Waters, n. sp.
Plate 26, figure 6

Test small, compressed, generally planispiral, the early coils slightly overlapping on opposite sides as the coils are made, but the resulting test in one plane is flattened on two sides; wall finely arenaceous with much cement; aperture formed by the

open end of the tubular second chamber. Diameter of holotype 0.50 mm.

Holotype (Cushman Coll. No. 7008) from 25 feet below the Palopinto limestone in Upper Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

There are a number of specimens of this species from the type locality which show the constancy of the specific characters. The early portion of the test appears as though divided into triangular chambers, but a close study shows that these are but overlappings of the coil as it embraces more on one side than the other in its coiling. In the last coils the overlapping becomes equal on the two sides, and an appearance similar to *Ammodiscus* results. In some respects this resembles *Glomospira pusilla* (Geinitz) but there is no appreciable thickening in the central portion of the test, and the peculiar angled appearance is due to the unequal overlappping rather than an actual change in direction of the coil.

GLOMOSPIRA UMBILICATA Cushman and Waters, n. sp.
Plate 26, figures 7, 8

Test fairly large for the genus, the elongated second chamber coiling with an angular direction at three points in each coil so that somewhat of a triangular form is produced, the coils not keeping to one plane but slightly twisting about, the early portion thin and appearing as an umbilicate area in the adult; wall finely arenaceous with a very large proportion of cement, rather smoothly finished; aperture at the end of the tubular second chamber. Diameter up to 1 mm.

Holotype (Cushman Coll. No. 7009) from Southwick shale, on Brady-San Saba Road, 3 miles east of Algerita, Texas.

This species is double the size of the preceding, and the make-up of the test is very different. In the triangular portion of the test the coil is usually somewhat keeled on the periphery. The convolutions leave an excavated umbilical region that is a feature of the specimens examined. The exterior is somewhat glossy and the tubular chamber is often marked by slight transverse markings.

PSAMMOPHIS INCLUSUS Cushman and Waters, n. sp.
Plate 26, figure 12

Test attached, basal side flattened, dorsal side convex, consisting of a proloculum and elongate tubular chamber, the latter in

its early stages close coiled planispirally, later the tube swinging back and forth about the early portion and partially embracing it; wall finely arenaceous with much cement and the dorsal surface somewhat roughened; aperture formed by the open end of the tubular chamber. Maximum diameter of holotype 0.85 mm.

Holotype (Cushman Coll. No. 7011) from 1 foot below Gunsight limestone, Graham, Young Co., Texas.

This species differs from *Psammophis inversus* Schellwein in having the embracing character of the chambers and the larger size.

TURRITELLELLA GRANDIS Cushman and Waters, n. sp.
Plate 26, figure 9

Test elongate, spiral, consisting of a proloculum and elongate tubular second chamber in an elongate close spiral, line between the coils distinct and depressed, wall arenaceous. Length of holotype 1 mm.; maximum breadth 0.40 mm.

Holotype (Cushman Coll. No. 7012) from 25 feet below the Palopinto limestone in Upper Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

This is a larger and coarser species than *Turritellella spirans* Cushman and Waters which we have described from the Carboniferous of Michigan.

AMMOBACULITES SPIRANS Cushman and Waters, n. sp.
Plate 26, figure 10

Test elongate, slender, the early chambers planispirally coiled, later chambers uncoiled but somewhat twisted in their development, so that an irregular biserial form is taken on in some parts of the uncoiled portion; wall arenaceous with a large proportion of cement, surface somewhat roughened; aperture rounded, terminal. Length of holotype 0.70 mm.; breadth 0.15 mm.

Holotype (Cushman Coll. No. 7014) from a sandy shale 5-10 feet above Thurber Coal, near base of Mineral Wells portion of Upper Strawn formation, brick plant at Thurber, Erath Co., Texas.

This species has proved to be fairly common and has some very interesting characters. The early chambers are normally planispiral but the later ones instead of the usual uniserial group become twisted so that two chambers occupy in certain aspects the position of one in the usual species of the genus.

This is especially significant as it may account for the rise of the biserial forms of the Textulariidae from planispiral forms. In typical *Spiroplectammina* (Pl. 26, fig. 11) there is a planispiral young with the remainder of the test composed of chambers arranged biserially. Each of the biserial chambers should be considered as a chamber making 180° of a circle so that two chambers make up a complete volution. The Textulariidae are thus in their biserial forms to be thought of as forms which are coiled about an elongate axis, two succeeding chambers making up a coil. In the Verneuilinidae, three chambers normally make a coil except in the forms such as *Gaudryina* where a return to the simpler form of two chambers to a coil is taken on in the adult after the triserial condition.

From this viewpoint *Ammobaculites spirans* becomes a very interesting species as perhaps indicating the stages that took place in the development of the biserial arenaceous forms.

SPIROPLECTAMMINA CLAVATA Cushman and Waters, n. sp.
Plate 26, figure 11

Test elongate, somewhat compressed, the sides nearly parallel or slightly increasing in width toward the apertural end, early chambers planispiral, later ones biserial, and about as long as broad; sutures distinct, those of the biserial portion nearly at right angles to the periphery; wall finely arenaceous with occasional coarser fragments but smoothly finished; aperture an elongate opening at the base of the inner margin of the chamber. Length of specimens up to 0.75 mm.; breadth 0.25 mm.

Holotype (Cushman Coll. No. 7017) from Gunsight limestone, Graham, Young Co., Texas.

Some of the specimens have a more swollen apertural end than that figured which gives a decided clavate shape to the test. The thickness in side view also increases toward the apertural end.

TEXTULARIA EXRAYENSIS Cushman and Waters, n. sp.
Plate 27, figures 2 *a*, *b*

Test compressed, the biserial portion of uniform thickness in side view, in front view rapidly increasing in breadth, periphery rounded; early chambers planispiral at least in the microspheric form, later ones biserial; sutures distinct and depressed, horizontal; wall rather coarsely arenaceous and the surface roughened; aperture narrow, at the base of the inner margin of the

chamber. Length of holotype 0.50 mm.; breadth 0.35 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 7019) from Upper Millsap formation, 100 feet below the coal, 3½ miles west of Exray, Texas.

It is somewhat difficult to determine whether this species should be referred to *Textularia* or to *Spiroplectammina*, but the test is much more biserial than planispiral, and the test is flaring like typical *Textularia*.

TEXTULARIA FUSCALIGNENSIS Cushman and Waters, n. sp.
Plate 27, figures 1 *a-c*

Test small, compressed, periphery rounded, in front view tapering from the initial end to the greatest breadth near the apertural end, in side view with the sides nearly parallel, early chambers planispiral, later ones biserial, about twice as long as high, of rather even proportions throughout, sutures distinct, depressed, oblique, straight or very slightly curved; wall finely arenaceous with a small proportion of cement; aperture a narrow elongate slit at the base of the inner margin of the chamber. Length of holotype 0.55 mm.; breadth 0.25 mm.; thickness 0.13 mm.

Holotype (Cushman Coll. No. 7021) from 35 feet below the Ranger limestone, 5.4 miles S. W. of Brown Wood, Brown Co., Texas.

This is a small but distinct species, and at the locality is common. The oblique sutures and even character of the chambers with the parallel sides will distinguish it from the other American species of the Palaeozoic.

TEXTULARIA GRAHAMENSIS Cushman and Waters, n. sp.
Plate 27, figures 3 *a, b*

Test slightly compressed in the young, rapidly thickening in the adult, tapering strongly in both front and side views, periphery rounded; chambers numerous, in the young with the width nearly double the height but becoming relatively higher in the adult; sutures horizontal, distinct, depressed strongly in the later portion; wall coarsely arenaceous; aperture large and rounded at the base of the inner margin of the chamber. Length of holotype 1.25 mm.; breadth 0.65 mm.; thickness 0.50 mm.

Holotype (Cushman Coll. No. 7023) from Gunsight limestone, Graham, Young Co., Texas.

This is the largest and stoutest of the species described here, and is very distinct from the others. The earliest chambers in the microspheric form are apparently planispiral.

TROCHAMMINA ARENOSA Cushman and Waters, n. sp.
Plate 27, figures 4 *a-c*

Test trochoid, much compressed, early chambers less compressed, later ones much compressed and spread out, four chambers in a whorl and three to four whorls in the test; sutures on the dorsal side slightly curved, on the ventral side nearly radial; wall rather coarsely arenaceous; aperture ventral, on the inner margin of the chamber. Diameter of holotype 0.65 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 7025) from 35 feet below Ranger limestone, 5.4 miles S. W. of Brown Wood, Brown Co., Texas.

This is a very much flattened and spreading species, the earlier chambers forming a low cone, the wall rather coarsely arenaceous. It is common at the type locality.

AMMOCHILOSTOMA (?) TRILOCULINA Cushman and Waters, n. sp.
Plate 27, figures 5 *a*, *b*

Test usually with three visible chambers in a planispiral coil; chambers subglobular, increasing in size as added, sutures very distinct, slightly depressed; wall finely arenaceous, with a large proportion of cement, smoothly finished; aperture slit-like at the base of the chamber in the median line and in the adult apparently two supplementary long slit-like openings at the sides of the chamber. Diameter of holotype 0.50 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 7027) from one foot below Gunsight limestone, Graham, Young Co., Texas.

In some characters this resembles *Bradyina* but in most of its characters it seems to have affinities with *Ammochilostoma,* especially with species as *A. galeata*. The two slit-like openings somewhat resemble those of *Bradyina* but apparently do not have the relationship to the sutures as is usual in species of that genus. The interior shows an irregularly trochoid series of chambers few in number, but the adult is planispiral. It is an abundant species at this locality. This is very different from *Bradyina holdenvillensis* Harlton which has five chambers and multiple apertures.

TETRATAXIS MULTILOCULATA Cushman and Waters, n. sp.
Plate 27, figures 6 *a*, *b*

Test much compressed, the early chambers forming a small low spire, later ones much spread out and toward the edge lobed and divided into numerous smaller chambers, sutures very distinct, slightly limbate; wall finely arenaceous, with a large proportion of cement; ventral side with the chambers only at the periphery, scale-like and overlapping. Diameter of holotype 1.60 mm.

Holotype (Cushman Coll. No. 7029) from Breckenridge limestone, 1 mile south of Breckenridge, Stephens Co., Texas.

This is a very fine species, the test strongly compressed and on the whole very different from the other described species.

EXPLANATION OF PLATE 26

FIG. 1. *Hyperammina glabra* Cushman and Waters, n. sp. × 70.

FIGS. 2, 3. *Nodosinella arenata* Cushman and Waters, n. sp. × 60. *a*, front view; *b*, apertural view. Fig. 2, holotype.

FIGS. 4, 5. *Nodosinella glabra* Cushman and Waters, n. sp. × 125. *a*, front view; *b*, apertural view. Fig. 4, holotype.

FIG. 6. *Glomospira duplex* Cushman and Waters, n. sp. × 90.

FIGS. 7, 8. *Glomospira umbilicata* Cushman and Waters, n. sp. × 60. Fig. 7, specimen showing the very strongly keeled periphery. Fig. 7, holotype.

FIG. 9. *Turritellella grandis* Cushman and Waters, n. sp. × 75.

FIG. 10. *Ammobaculites spirans* Cushman and Waters, n. sp. × 100.

FIG. 11. *Spiroplectammina clavata* Cushman and Waters, n. sp. × 90.

FIG. 12. *Psammophis inclusus* Cushman and Waters, n. sp. × 70.

EXPLANATION OF PLATE 27

FIGS. 1 *a–c*. *Textularia fuscalignensis* Cushman and Waters, n. sp. × 100. *a*, front view; *b*, side view; *c*, end view.

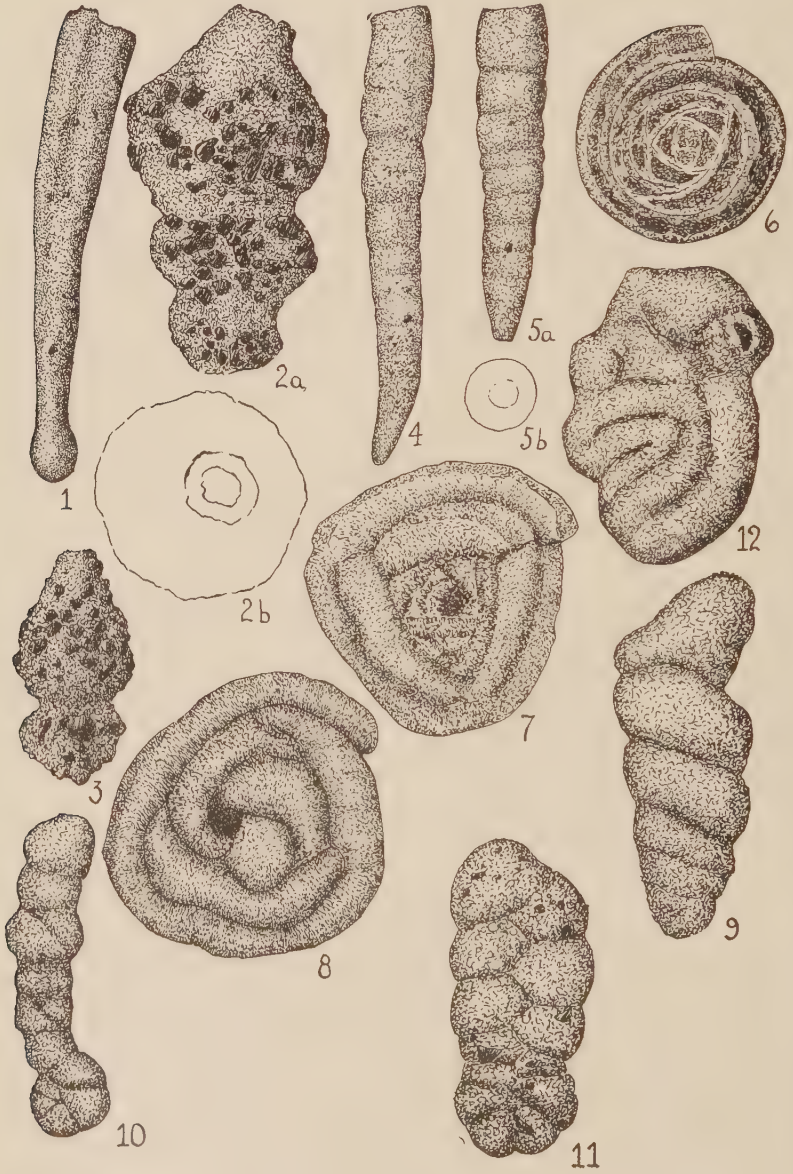
FIGS. 2 *a*, *b*. *Textularia exrayensis* Cushman and Waters, n. sp. × 100. *a*, front view; *b*, side view.

FIGS. 3 *a*, *b*. *Textularia grahamensis* Cushman and Waters, n. sp. × 70. *a*, front view; *b*, side view.

FIGS. 4 *a–c*. *Trochammina arenosa* Cushman and Waters, n. sp. × 85. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

FIGS. 5 *a*, *b*. *Ammochilostoma* (?) *triloculina* Cushman and Waters, n. sp. × 100. *a*, side view; *b*, apertural view.

FIGS. 6 *a*, *b*. *Tetrataxis multiloculata* Cushman and Waters, n. sp. × 45. *a*, dorsal view; *b*, peripheral view.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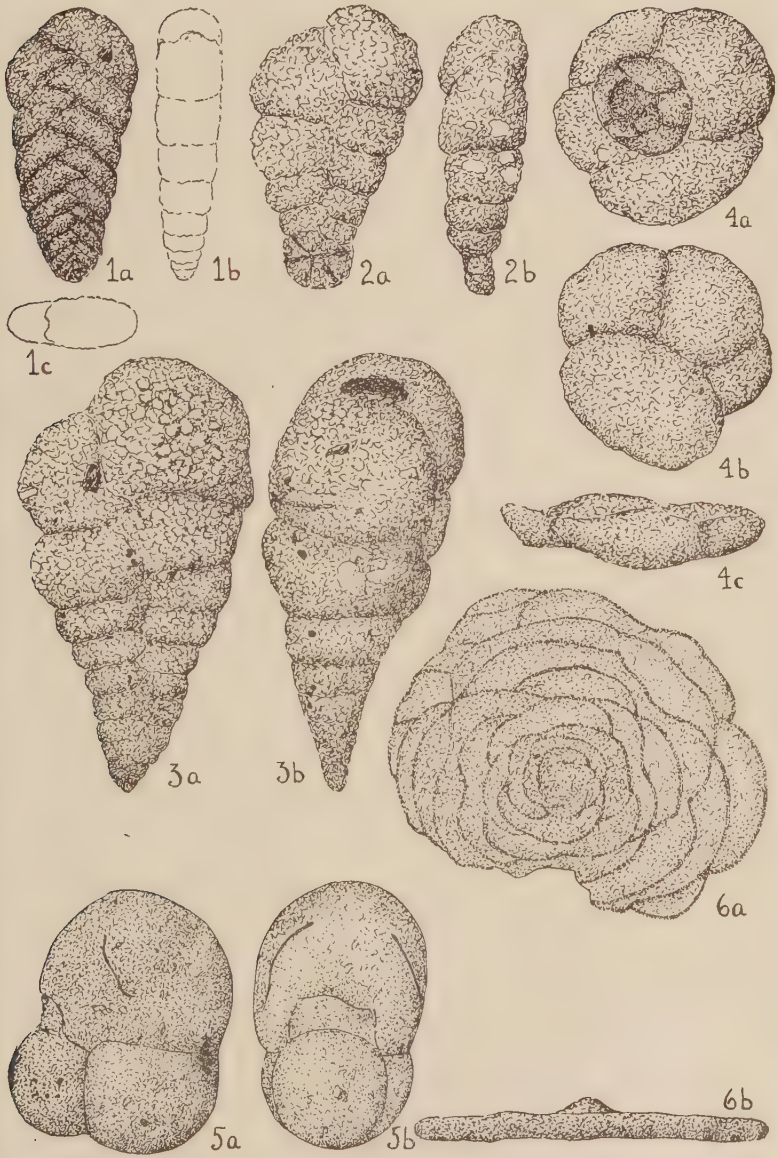
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47. ADDITIONAL NOTES ON THE GENUS PLEUROSTOMELLA

By Joseph A. Cushman

In the notes on this genus in the previous part of these Contributions, pp. 128-135, a few forms were not figured. I am indebted to Mr. Edward Heron-Allen who has kindly furnished me tracings from Hantken's work and to Dr. W. L. F. Nuttall who has called my attention to two forms omitted in the original paper—

The figures omitted on the previous plate, plate 25, are as follows—

Pleurostomella bellardi Hantken—(see Pl. 28, fig. 1).

Pleurostomella incrassata Hantken—(see Pl. 28, figs. 2, 3).

Pleurostomella tenuis Hantken—(see Pl. 28, fig. 4).

The following were omitted in the original paper:

Pleurostomella acuta Hantken, var. *buliminiformis* Terrigi, Mem. R. Com. Geol. Ital., vol. 4, 1891, pl. 1, fig. 25. This is from the Pleistocene or Pliocene of Italy. (See Pl. 28, fig. 5.)

Pleurostomella rapa Gümbel, var. *recens* Dervieux, Boll. Soc. Geol. Ital., vol. 18, 1899, p. 77. This varietal name is proposed by Dervieux for the recent form figured by Brady in the *Challenger* Report, pl. 51, figs. 21 *a*, *b*, and which is not the same as Gümbel's species from the Eocene of the Bavarian Alps. Brady's specimen is from off the Ki Islands, Indo-Pacific, *Challenger* Station 192. (See Pl. 28, fig. 6.)

EXPLANATION OF PLATE 28

Figs. 1 *a*, *b*. *Pleurostomella bellardi* Hantken (After Hantken). *a*, front view; *b*, side view.

Figs. 2, 3. *Pleurostomella incrassata* Hantken (After Hantken). *a*, front view; *b*, side view.

Figs. 4 *a*, *b*. *Pleurostomella tenuis* Hantken (After Hantken). *a*, front view; *b*, side view.

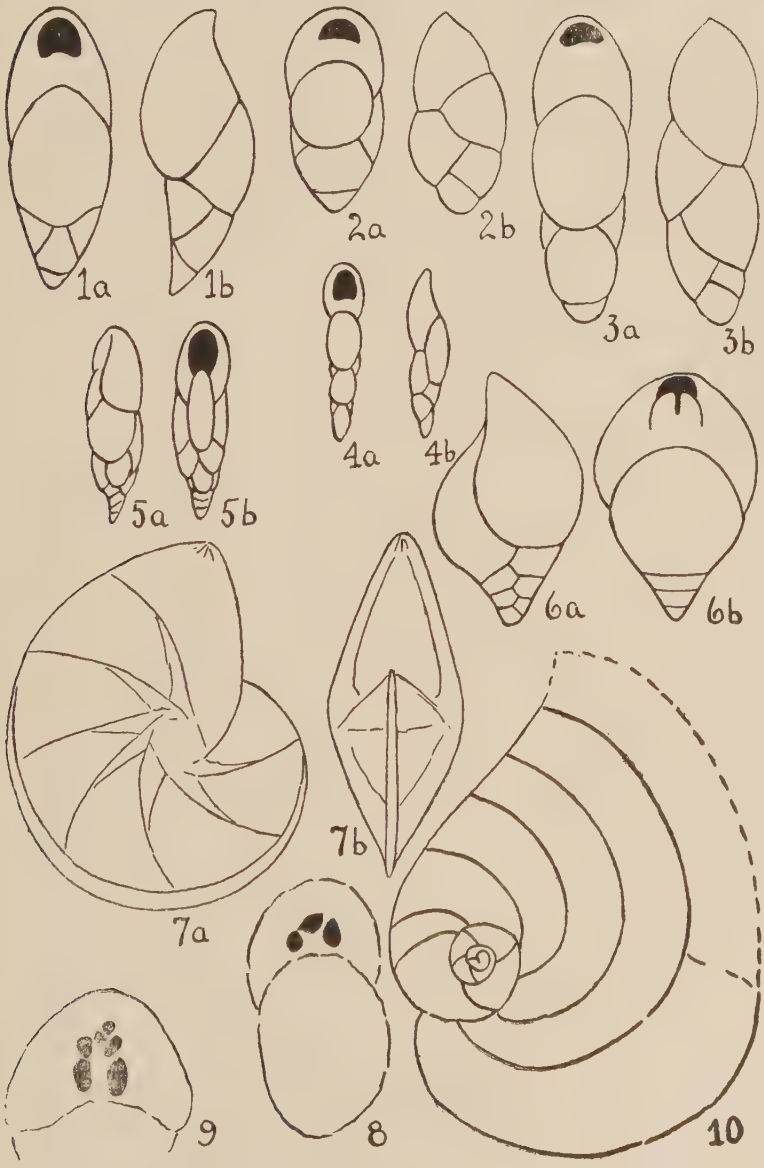
Figs. 5 *a*, *b*. *Pleurostomella acuta* Hantken, var. *buliminiformis* Terrigi (After Terrigi). *a*, side view; *b*, front view.

Figs. 6 *a*, *b*. *Pleurostomella rapa* Gümbel, var. *recens* Dervieux (After H. B. Brady). *a*, side view; *b*, front view.

Figs. 7 *a*, *b*. *Lenticulina rotulata* Lamarck. (From type specimen). *a*, side view; *b*, apertural view.

Figs. 8, 9. *Lituola nautiloidea* Lamarck. Showing multiple apertures increasing in number. From specimens on the type slide.

Fig. 10. *Renulina opercularia* Lamarck. Specimen from Grignon showing the developmental stages.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48. The GENERA RENULINA AND VERTEBRALINA

By Joseph A. Cushman

In 1804 Lamarck gave a description of the genus *Renulina* in the following terms (Annales du Museum, vol. 5, 1804, p. 353): "Testa reniformis, complanata, sulcata, polythalamia: loculis linearibus, secundis curvis: ultimis longioribus. Axis marginalis." The type species is *Renulina opercularia* Lamarck (l. c. p. 354). The type specimens are from the Eocene of the Paris Basin from Grignon. I examined at Caen the type slide in the Defrance collection. This has a large series of beautiful specimens which show the full adult characters. The species is described as follows: "semilunaris, planissima; sulcis arcuatis concentricis." In his paragraph of further comment on the species, more is given of its characters. It is later figured (l. c. vol. 9, 1807, pl. 17, fig. 6). The specimen figured by Lamarck was evidently an adult, and the measurement is given as 3 mm.

In material I have from the type locality there are a number of specimens of this species, but none which show the complete adult characters as shown by Lamarck and by the type specimens, and none of my specimens are as large as the measurement he gives.

A study of this suite of specimens shows an oval proloculum with the second chamber, but about a third of a coil in length such as I have figured (Bull. 71, U. S. Nat. Mus., pt. 6, 1917, p. 12, text fig. 10), (see pl. 28, fig. 10). The third chamber makes nearly a complete coil. After this *Cornuspira*-like stage, chambers slightly flaring are built, each about a third of a coil in length. After three or four such chambers are built, the following ones are very low and rapidly broaden especially on one side, and finally in the adult reach back on both sides and nearly envelop the earlier test on the periphery. The test is very thin and flat, the wall smooth except in the earliest chambers which are slightly striate longitudinally. One of the important points is that the test is coiled entirely in one plane and not at all involute, all the chambers back to the proloculum being visible from either side. The aperture is very elongate, exactly median, and extending the entire width of the apertural face. This gives a very weak structure, although there are

occasional indications of a trussing across which might strengthen the test somewhat.

Nothing is known of this genus outside the Eocene of the Paris Basin, and almost all the later figures are copies of that of Lamarck. Terquem (Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 50, pl. 2 [10], figs. 29 *a, b*) gives a figure of "*Peneroplis opercularis* d'Orbigny" which is probably intended for this species. He indicates that the aperture is filled by a plate with small perforations, a character I have failed to find in any of my specimens. This specimen was from the Eocene of the Paris Basin at Vaudancourt given as "very rare," which may explain my not being able to find it in my material from that locality. This may also be the same as d'Orbigny's *Peneroplis orbicularis* of the 1826 Tableau afterward figured by Fornasini.

There is then in the Paris Basin Eocene a genus which has been placed by Brady and others as a synonym of *Vertebralina*. If the two are synonymous, Lamarck's name is much older. The two, however, seem to be very distinct.

Vertebralina was described by d'Orbigny in 1826 (Ann. Sci. Nat., vol. 7, 1826, p. 282) as follows: "Test très-déprimé; spire se projetant à un certain âge en ligne droite: ouverture en fente, occupant toute la partie supérieure de la derniére loge." There is a single species which simplifies the selection of the type, *V. striata* d'Orbigny, illustrated by Modèle No. 81. The localities given are "la Mediterranee, la mer Rouge, et la mer du Sud, a Rawack."

d'Orbigny's Model No. 81 I have before me and a series of Mediterranean specimens which fit it very closely. There can be little doubt as to *Vertebralina striata* d'Orbigny which is a common species of the Mediterranean. The differences between it and *Renulina* are very decided. The most striking of these is the fact that the early chambers are hidden as the chambers are involute. In the earlier portion which is close coiled, two chambers make up a coil as a rule, although this is not true in the adults of some species which have several. The chambers in the later development become uniserial in the type species, but show none of the tendency of *Renulina* to extend backward on two sides. The tendency is rather to develop a uniserial test with nearly parallel sides. The aperture also which was entirely median in *Renulina*, in *Vertebralina* has a decidedly different aspect from the two sides. There is an "upper lip" that is broader and an "under lip" that is narrower, the upper completely hiding the lower from the upper side, but from the other

side the lower does not cover the upper one. The whole test is really bilateral in most of its other features.

Vertebralina is best developed in the present oceans in warm, shallow water, but is known well back into the Tertiary.

It seems, therefore, that there are two distinct genera, *Renulina* Lamarck and *Vertebralina* d'Orbigny, somewhat closely related but nevertheless very distinct in all their essential characters.

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

Plummer, Helen Jeanne.

Foraminifera of the Midway Formation in Texas.

(Univ. Texas Bull. No. 2644, Nov. 22, 1926 [April 1927], pp. 1-206, 15 pls., 13 text figs., table.) *Austin.*

An excellent, beautifully illustrated paper on the lowest Eocene. There are 103 species and varieties noted, of which 46 are described as new.

Stefanini, Giuseppe.

Sull'esistenza di Dictyoconoides nell'Eocene medio della Somalia settentrionale.

(Atti della Societa dei Naturalisti e Matematici di Modena, ser. 6a, vols. V-VI [57-58], fasc. 2, 1927, pp. 84-86.) *Forli.*

Notes on the occurrence of this peculiar species in Eastern Africa.

Douvillé, H.

Les Orbitoides de la region petrolifere du Mexique.

(Compt. Rend. Somm. Seanc. Soc. Géol. France, 1927, fasc. 4, Feb. 21, 1927, pp. 34, 35, 4 text figs.) *Paris.*

Notes are given on several genera, and one new species is figured.

Cushman, Joseph A. and G. Dallas Hanna.

Foraminifera from the Eocene near Coalinga, California.

(Proc. California Acad. Sci., ser. 4, vol. XVI, No. 8, April 22, 1927, pp. 205-229, pls. 13, 14.) *San Francisco.*

There are 33 forms noted, of which 9 are described as new.

Cushman, Joseph A. and Marcus A. Hanna.

Foraminifera from the Eocene near San Diego, California.

(Trans. San Diego Soc. Nat. Hist., vol. V, No. 4, March 15, 1927 [May 1927], pp. 45-64, pls. 4-6.) *San Diego.*

There are 21 forms noted, of which 4 are described as new.

Cushman, Joseph A. and U. S. Grant, IV.
Late Tertiary and Quaternary Elphidiums of the West Coast of North America.
(Trans. San Diego Soc. Nat. Hist., vol. V, No. 6, July 28, 1927, pp. 69-82, pls. 7, 8.) *San Diego.*
Five species are noted, of which 3 are new.

Franke, A.
Neuere Erfahrungen über die Aufbewahrung und die Sammlung von Mikrofossilien.
(Zeitschr. Deutsch. Geol. Ges., Bd. 79, 1927, pp. 46-48.) *Berlin.*

Franke, A.
Neuere Erfahrungen über die Präparation und Aufbewahrung von Mikrofossilien.
(Pal. Zeitschr., vol. IX, Heft. 1, 1927, pp. 109-111.) *Berlin.*
These two papers describe methods of mounting and storing collections of foraminifera.

Silvestri, A.
Sulla *Conulites cooki* del Carter.
(Riv. Ital. Pal., Ann. XXXIII, 1927, pp. 23-36, pls. 1, 2, 1 text fig.) *Parma.*
The relationships of this form are discussed and figures given, as well as those of related forms.

Wengen, W. à
Phylogenetic Considerations of the Nummulinidae.
(Proc. Fourth Dutch East Indian Congress of Natural Science, Weltevreden [Java], Sept. 22 to 26, 1926, Geographic-Geologic Section, 1927, pp. 448-466, 3 charts.) *Weltevreden.*
Very interesting discussions are given of relationships with geologic and geographic occurrences in the Nummulite and Orbitoid groups.

Franke, A.
Die Foraminiferen und Ostracoden des Palaeocäns von Rugaard in Jütland und Sundkrogen bei Kopenhagen.
(Danmarks Geol. Unders., II Rackke, Nr. 46, 1927, pp. 1-49, pls. 1-4.) *Kjobenhavn.*
There are 75 species described with many varieties and forms, of which 7 are new.

Silvestri, A.
Fossili Esotici nel Paleogene della Brianza.
(Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, vol. 66, 1927, pp. 105-121, 3 pls., 3 text figs.) *Milano.*
Some good figures of sections of *Lituonella* and other large genera are given.

Cushman, Joseph A.
Description of Foraminifera.
(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 13, 14.) *Chicago.*
Notes relative to descriptive work are given.

Harlton, Bruce H.
Some Pennsylvanian Foraminifera of the Glenn Formation of Southern Oklahoma.
(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 15-27, pls. 1-5.) *Chicago.*
Thirty-one forms are discussed, of which 13 are described as new.

Galloway, J. J. and Stanley G. Wissler.
Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California.
(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 35-87, pls. 7-12, 2 tables.) *Chicago.*
There are 79 species described and figured, 41 of which are described as new, and one new genus, *Carinina.*

Moreman, W. L.
Fossil Zones of the Eagle Ford of North Texas.
(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 89-101, pls. 13-16, 1 text fig.) *Chicago.*
There are 12 species of foraminifera noted, 2 described as new.

Waters, James A.
A Group of Foraminifera from the Dornick Hills Formation of the Ardmore Basin.
(Journ. Pal., Vol. 1, No. 2, August 1927, pp. 129-133, pl. 22.) *Chicago.*
There are ten forms noted, all described as new.

Thomas, N. L.
The Use of Evolutionary Changes in Geologic Correlation.
(Journ. Pal., Vol. 1, No. 2, August 1927, pp. 135-139.) *Chicago.*

The foraminifera are used to show the changes that may be used to advantage in correlation.

Thomas, N. L. and E. M. Rice.
Changing Characters in some Texas Species of Guembelina.
(Journ. Pal., Vol. 1, No. 2, August 1927, pp. 141-144, text figs.) *Chicago.*

The changes that took place in the Cretaceous Guembelinas of Texas are discussed.

Cushman, Joseph A.
Some Characteristic Mexican Fossil Foraminifera.
(Journ. Pal., Vol. 1, No. 2, August 1927, pp. 147-172, pls. 23-28.) *Chicago.*

Seventy-two of the more striking Cretaceous and Tertiary forms of Mexico are noted, and mostly figured, 6 described as new.

Ikari, Jiro.
A list of *Foraminifera* found in the Bottom-Sand, which was collected at Misaki.
(The Suisangaku Zasshi, No. 30, 1927, pp. 1-8, pls. 1, 2.) *Sapporo.*

Thirty-six species are noted and figured, one of which is new. The plates are excellent.

Cushman, Joseph A.
Recent Foraminifera from off the West Coast of America.
(Bull. Scripps Inst. Oceanography, Technical Series, Vol. 1, No. 10, Sept. 1927, pp. 119-188, pls. 1-6.) *Berkeley.*

There are 142 species and varieties noted, of which 21 are described as new.

Cushman, Joseph A.
Phylogenetic Studies of the Foraminifera. Part II.
(Amer. Journ. Sci., vol. XIV, Oct. 1927, pp. 317-324, 24 figs.) *New Haven.*

The families Textulariidae, Verneuilinidae and Valvulinidae are discussed.

J. A. C.

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

VOLUME 3, PART 4, DECEMBER, 1927

49. TRIMORPHISM IN THE FORAMINIFERA

By Joseph A. Cushman

The question of specific limits in the foraminifera is a difficult one at best, but the generic position of species is also at times a very perplexing one. In 1925, Hofker published a paper entitled: "On Heterogamy in Foraminifera" (Tijdschr. Ned. Dierk. Vereen, ser. 2, vol. 19, 1925, pp. 68-70) in which he reviews much of the work that has been done on the life history of the foraminifera, and comes to the conclusion that there are three forms in each "species." One results in the microspheric form from the union of flagellispores, with a microspheric proloculum. The ultimate size of the adult test is large, and its developmental stages the most complete of the three forms. This microspheric form may give rise to several generations of megalospheric forms, some with a very large proloculum, others much smaller and gradations between the two extremes.

In his most recent work on the Foraminifera of the Siboga Expedition, Hofker has applied his theory of the existence of three forms in each species to the material collected by that expedition with results that will be startling to some who have not studied large series, especially of tropical foraminifera. To think that "species" usually placed in different genera should be forms of one and the same species is perhaps difficult for some, but there are many such actual cases in the literature as well as shown in recent material. The effect upon the already complicated nomenclature will be very confusing, and the Rules of Nomenclature will be sure to have peculiar applications. A classic example of this trimorphism is found in d'Orbigny's

work on the Foraminifera of the Vienna Basin. On Plate 1, fig. 26 is "*Nodosaria aculeata* d'Orbigny" with a very large proloculum and with four chambers in a rectilinear arrangement, the surface coarsely spinose. On Plate 2, fig. 16 is "*Dentalina floscula* d'Orbigny" with a smaller proloculum, and with six chambers, the axis of the earlier ones slightly curved, the surface coarsely spinose. On Plate 3, fig. 17 is "*Marginulina hirsuta* d'Orbigny" with a still smaller, probably microspheric proloculum, the number of chambers indefinite but at least nine, the earlier ones in a strong curve. I have abundant material from Baden, and these forms with some intermediates are present, the "*Marginulina*" in some specimens compressed laterally in the young, and with a very small proloculum. There can be no doubt in a study of this series but that a single species is present.

If according to the Rules of Nomenclature, the first of these is chosen as the type, it will be called "*Nodosaria aculeata* d'Orbigny," but with it must be put the Dentaline and Marginuline forms which would very greatly stretch the definition of *Nodosaria* to say the least. If on the other hand the name be "*Marginulina hirsuta* d'Orbigny" as that form shows the greatest number of chambers and the most nearly complete life history, these other megalospheric forms may be grouped with it as forms with incomplete stages with perhaps less difficulty.

In our California Pleistocene and Pliocene as well as in the living forms of the Eastern border of the Pacific along North and South America, we have a broad form described as *Truncatulina ornata* d'Orbigny. In this species which becomes in large specimens very broad and a true *Planulina* (Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, No. 10, p. 176, pl. 6, fig. 12) there is another form which at first would seem unrelated, but occurs with it both fossil and at many stations off the coast which is biconvex. This has recently been named "*Cibicides mckannai*" by Galloway and Wissler (Journ. Pal., vol. 1, 1927, p. 65, pl. 10, fig. 5 *a*, *b*). There is a third form which fills in the intermediate stages between the two, and all three forms belong to d'Orbigny's species. Two forms with such different shapes and stages are even more distinct at first sight than those of d'Orbigny cited above, but when hundreds of specimens are studied from numerous stations and the various intermediates studied, the real limits of the species in its different forms are to be seen. Some of the examples given by

Hofker are perhaps even more striking than these.

There are however some species which although they occur in both microspheric and megalospheric forms and perhaps the second megalospheric form or forms keep closely to a single generic character. Many species have fixed characters that enable them to become index fossils of close horizons and to have very limited geographical ranges in the present oceans.

One of the beneficial things that comes from this varied form is its effect upon our classification of the group. It can hardly be that various generic characters assumed by the different forms of a species can be other than closely related, and the young of the microspheric form will give very strong clues to the relationship of the different genera involved. It is very clear that *Planulina* and *Cibicides* (*Truncatulina*) are closely related genera, and that *Marginulina, Dentalina* and *Nodosaria* developed in that order from a close coiled ancestry. So one studying the rare microspheric forms of *Globigerina* with the early stages flattened, non-spinose and like *Discorbis* such as figured by Rhumbler (Plankton Exped. Foraminifera, 1911, pl. 32, and others) must come to the idea that the Globigerinas are a specialized group derived from a smooth *Discorbis*-like ancestry through high specialization. Such characters will help to clear our classification at the same time that it may confuse our ideas as to what to call a species and in what genus it should be placed.

It may be argued that *Nodosaria, Dentalina* and *Marginulina* are not good genera if one species may assume forms so diverse that it might be placed in all three genera. On the other hand, there are apparently many species which as far as we know do not jump across generic lines as do these. The Lagenidae are primitive and plastic, and close distinctions are not as possible as in some other groups.

Hofker's studies show that one should be slow to describe new species from single or even few specimens, and that it is very necessary to know whether a specimen is a microspheric or megalospheric one. Sectioned specimens are of great value, and the publication of really good sections is sure to help greatly in the study of many foraminifera.

The extent of the application of Hofker's ideas is not yet apparent, but enough is known of the various forms which the foraminifera assume to show that it should be given very wide testing and its possibilities on the matter of nomenclature be carefully considered.

50. THE WORK OF FICHTEL AND MOLL AND OF MONTFORT

By Joseph A. Cushman

The work of Fichtel and Moll, Testacea Microscopica, published in Vienna in 1798 with twenty-four colored plates, all but the first one of foraminifera, is the most important of the earlier works on the foraminifera. The still earlier works on which Linné based his few species of foraminifera are not well illustrated. The work of Fichtel and Moll is for the most part excellently illustrated, and in my own copy the colors of the plates are beautifully preserved in spite of their age. The work of Fichtel and Moll is important for the specific names used, all of which are referred to *Nautilus*, but also as the basis on which genera were erected by numerous later authors. The first of these is Denys de Montfort. In the first volume of his Conchyliologie Systématique, he erected a great many genera, most of them based on the figures in Fichtel and Moll. His drawings are very crude wood cuts which try to unite in one figure two or more views, and occasionally he makes a composite figure based on figures of specimens which belong to different genera. Were it not that Montfort refers definitely to the figures of Fichtel and Moll, more of his generic names could be discarded. Unfortunately, Montfort does not refer to the work of Lamarck published in 1801 and 1804. Lamarck's names precede those of Montfort in a number of genera.

The material which Fichtel and Moll had came from several sources. Four of these give most of the species. These are Rimini, the locality on the Italian coast of the Adriatic from which many of the species came which were recorded by Gaultieri, Bianchi, Linné, Soldani and afterward by d'Orbigny. It is one of the most famous of the localities for foraminifera. Coroncina, near Siena, a quarry in the Pliocene was the original type locality of another considerable lot of species and a locality made famous by both earlier and later writers. Material from the concretions from the Mediterranean gave many species as well as sands from the Red Sea. In order to have for study topotype material in considerable amounts, I made special col-

lecting trips last July to both Rimini and Coroncina, in both places foraminiferal material being abundant. I have also Mediterranean material which is probably more or less similar to that which Fichtel and Moll had. For the Red Sea material, I am indebted to Mr. W. A. Macfadyen who has supplied me with an excellent series of samples of his own collecting. With the study of Lamarck's types of species before 1808, it is possible to interpret much of the earlier work.

Montfort gave a generic name to nearly all of the separate figures of Fichtel and Moll's work so that his genera are monotypic ones. They may for convenience be grouped. There are sixteen generic names given by Montfort to forms which have usually been known as *"Cristellaria."* I found at Caen the types of Lamarck's *Lenticulina rotulata* which is a typical *"Cristellaria"* and if the name *"Cristellaria"* is to be disturbed, *Lenticulina* Lamarck must be used for it. There may be a difference of opinion among workers as to the extent to which *"Cristellaria"* may be usefully subdivided. The group is one of the most plastic of any of the foraminifera. The genus *Robulus* of Montfort may be retained for those species which have the radiate aperture and in addition a rounded opening below the apex in the apertural face, but the gradations between the purely radiate forms of aperture and those with the additional opening are closely bridged.

Under *Lenticulina* Lamarck the following genera of Montfort may be placed as more or less synonymous.

Phonemus Montfort Genus III, pp. 10-12; *Pharamus,* Genus IX, pp. 34-36; *Antenor,* Genus XVIII, pp. 70-72; *Oreas,* Genus XXIV, pp. 94-96; *Patrocles,* Genus LV, pp. 218-220; *Spincterules,* Genus LVI, pp. 222-224; *Clisiphontes,* Genus LVII, pp. 226-228; *Herion,* Genus LVIII, pp. 230-232; *Rhinocurus,* Genus LIX, pp. 234-236; *Macrodites* (?), Genus LX, pp. 238-240; *Lampas,* Genus LXI, pp. 242-244; *Scortimus,* Genus LXIII, pp. 250-252; *Linthurus,* Genus LXIV, pp. 254-256; *Astacolus,* Genus LXVI, pp. 262-264; and *Periples,* Genus LXVIII, pp. 270-272. A number of these "genera" have the apertural face with the supplementary aperture, and as such may be perhaps placed under *Robulus,* Genus LIV, pp. 214-216. Among these are *Phonemus, Pharamus, Patrocles, Spincterules, Herion, Rhinocurus, Scortimus, Linthurus,* and *Astacolus.*

The first of the generic names for what was later called *Polystomella* Lamarck is *Elphidium* Montfort, Genus IV, pp. 14-

16. Under this as synonyms may be grouped several names of Montfort, *Geophonus,* Genus V, pp. 18-20; *Pelorus,* Genus VI, pp. 22-24; *Chrysolus,* Genus VII, refers to Plate 19, figs. *g, h, i,* as does *Astacolus* later, but neither is close to the figures of Fichtel and Moll; *Andromedes,* Genus X, pp. 38-40; *Sporilus,* Genus XI, pp. 42-44; *Themeon,* Genus LI, pp. 202-204, and *Cellanthus,* Genus LII, pp. 206-208.

Nonion Montfort, Genus LIII, pp. 210-212 with the type *N. incrassatus* Fichtel and Moll, could hardly be distinguished, but for the original figures of Fichtel and Moll. Under *Nonion* as synonyms may be grouped *Melonis,* Genus XVII, pp. 66-68; and *Florilus,* Genus XXXIV, pp. 134-136.

Cibicides Montfort, Genus XXXI, pp. 122-124, must take the place of *Truncatulina* of d'Orbigny, 1826. *Polyxenes,* Genus XXXV, pp. 138-140, is probably a synonym.

Eponides Montfort, Genus XXXII, pp. 126-128, now takes the place of *Pulvinulus* Lamarck and *Pulvinulina* of later authors, as the same species *Nautilus repandus* Fichtel and Moll is the type species of each.

Camerina Bruguière has as synonyms from Montfort's names *Lycophris* (?), Genus XL, pp. 158-160; *Rotalites,* Genus XLI, pp. 162-164; and *Egeon,* Genus XLII, pp. 166-168.

Of the names given to the forms later called *Alveolina,* the first is *Borelis* Montfort, Genus XLIII, pp. 170-172. A synonym of this is *Clausulus,* Genus XLV, pp. 178-180.

Orbitolites Lamarck may have *Discolites,* Genus XLVII, pp. 186-188 as a synonym, but the figure and description are both poor.

Archaias Montfort, Genus XLVIII, pp. 190-192, is the first name used for what was later given the name *Orbiculina*; *Helenis,* Genus XLIX, pp. 194-196 and *Ilotes,* Genus L, pp. 198-200, are synonyms of *Archaias.*

Peneroplis Montfort may be used for the flattened forms while *Spirolina* Lamarck, 1804, is used for the uncoiled more or less cylindrical forms.

Cancris Montfort, Genus LXVII, pp. 266-268 based on Fichtel and Moll's pl. 20, figs. *d, e, f,* has the type *Cancris auriculus* (Fichtel and Moll), common in the Mediterranean and elsewhere.

Reophax Montfort has long been used, although there are but the two figures of Soldani and Montfort to depend upon. Soldani's types are in Siena, but I was unable to see the specimens

on which Soldani's figure was based and which was used by Montfort who drew a very extraordinary figure from it to illustrate his genus.

Of the other genera given by Montfort, nearly all are unidentifiable as they are not based on good figures of other authors, or like *Tinoporus*, Genus XXXVII, pp. 146-148 which is evidently made up of a combination of more than one genus and is a figure of a "hybrid" form which does not exist in nature.

It will be seen from the foregoing that fortunately very few of the names given by Montfort have generic standing. Of these there are the following: *Elphidium* for forms commonly known as *Polystomella*; *Nonion* for *Nonionina*; *Cibicides* for *Truncatulina* in general; *Eponides* for some of the species which have been called *Pulvinulina*; *Borelis* for *Alveolina* (in part); *Archaias* for *Orbiculina*, *Peneroplis*, *Cancris* for some of the species that have been called *Pulvinulina*, and *Reophax*.

51. SOME NOTES ON THE GENUS CERATOBULIMINA

By Joseph A. Cushman and Reginald W. Harris

In 1851, Reuss described the species *Rotalina contraria* (Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 76, pl. 5, fig. 37) from the Oligocene of Hermsdorf near Berlin. Many authors have referred fossil and recent specimens to this species, usually under the generic name *Bulimina*. That these various forms do not belong to *Bulimina* has long been evident. Toula in 1920 (Jahrb. Geol. Reichsanst., vol. 64, 1920, p. 665) erected the genus *Ceratobulimina* with the genotype *Rotalina contraria* Reuss. To this genus should be referred many other species. We are indebted to Mrs. Helen J. Plummer and Mr. W. J. Parr for some excellent specimens.

Genus CERATOBULIMINA Toula, 1920

Genotype, monotypic, *Rotalina contraria* Reuss

Ceratobulimina Toula, Jahrb. Geol. Reichsanst., vol. 64, 1920, p. 665.
Rotalina Reuss (in part) (not of d'Orbigny), Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 76.

Cassidulina H. B. BRADY (in part) (not of D'ORBIGNY), Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59.

Bulimina H. B. BRADY (in part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 409.

Buliminella CUSHMAN (in part), Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 89.

Pulvinulina RZEHAK (in part) (not of PARKER and JONES), Ann. K. K. Nat. Hofmuseums, vol. 3, pt. 3, 1888, p. 263.

Rotalia PLUMMER (in part) (not of LAMARCK), Univ. Texas Bull. 2644, 1927, p. 156.

Test rotaliform, all chambers visible from the dorsal side, those of the last-formed whorl only visible on the ventral side, close coiled; chambers numerous, distinct; wall thick, added to as growth progresses, the entire exterior polished; ventral side of the test with the umbilicus open, the aperture extending into the ventral side of the last-formed chamber, and in perfect adult specimens the aperture covered by a thin convex plate merged with the chamber wall above the aperture in a semicircular line, the lower end thin, lip-like.

The peculiar aperture which characterizes the genus is evidently too open for the best success of the animal, and as a consequence the protecting plate was developed. This is present in well preserved specimens at least in the adult condition. It may be broken away as in Pl. 30, fig. 16 showing the aperture below and often one or more of the plates of the previous chambers. The wall is continuously being added to with the new chambers giving a stratified appearance in section (Pl. 30, fig. 14). This is also seen in *Cassidulina* and other genera derived from *Ceratobulimina*. As chambers are broken back it is seen (Pl. 30, fig. 15) that there is a partition built in across the lower portion of the apertural opening shutting the upper portion off into a semicircular portion. This is evidently a secondary structure, and appears only in those chambers which have been covered by later ones. One end of this partition seems to be attached below the original apertural face. The very smooth character of the surface appears like that of *Cypraea* in the Mollusca where the mantle covers the entire test, and is in *Ceratobulimina* probably due to the fact that the protoplasm covers the entire test, a fact borne out by the laminated character of the wall due to continual thickening.

A study of available material seems to show that *Ceratobulimina* like many other genera probably originated in the Upper Cretaceous from a *Discorbis*-like ancestry. It is closely related

to *Pulvinulinella* and *Cassidulina* which were probably derived from it in the Eocene. All three genera are still living, most abundantly in the Pacific.

A description of some of the species follows:

CRETACEOUS SPECIES

CERATOBULIMINA CRETACEA Cushman and Harris, new species
Plate 29, figures 1 *a-c*; Plate 30, figure 11

Test small, slightly longer than broad, usually 7 chambers in the last-formed whorl; sutures distinct, limbate but not raised; wall smooth, polished; aperture extending slightly into the last-formed chamber in a rounded triangular opening, covered in well preserved specimens with a slightly developed thin plate attached above the inner end of the aperture. Length 0.43 mm.; breadth 0.30 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 7030) from Upper Cretaceous, Navarro formation of Mexia Oil Field, Mexia, Texas.

This is the most primitive of the species of the genus so far seen. The aperture does not extend so far into the apertural face, and the protecting plate is only partially developed.

EOCENE SPECIES

CERATOBULIMINA PERPLEXA (Plummer)
Plate 29, figures 2 *a-c*

Rotalia perplexa PLUMMER, Univ. Texas Bull. 2644, 1927, p. 156, pl. 12, figs. 2 *a-c*.

"Test oval, about equally biconvex, considerably compressed; peripheral margin broadly rounded, somewhat lobate; chambers smooth, glistening, finely punctate, gently curving, 6 to the final whorl; dorsal sutures marked by thick, smooth or very slightly elevated, tapering bands that become distinctly angular at their broadest points; ventral sutures depressed, radiate from a sunken umbilicus; aperture a conspicuous round opening at the base of the septal face and protected by an arched flap that is directed into the umbilicus.

"Length up to .5 mm.; average .35 mm."

The types are from the Midway Eocene of Texas, and it is recorded by Mrs. Plummer from the topmost Navarro and from the Wilcox at Nanafalia, Alabama.

CERATOBULIMINA EXIMIA (Rzehak)
Plate 29, figures 3, 4; Plate 30, figures 12-16

Pulvinulina eximia RZEHAK, Ann. K. K. Nat. Hofmuseums, vol. 3, pt. 3, 1888, p. 263, pl. 11, figs. 7 *a-c*.

Test slightly longer than broad, broadly oval in peripheral view, 7-9 chambers in the last-formed whorl, distinct; sutures distinct, either depressed or becoming thickened, limbate and sometimes even raised on the dorsal side, the later sutures with a conspicuous angle near the inner margin; wall thick, smooth and highly polished; aperture, a broad somewhat oblique opening in the ventral side of the last-formed chamber, in fully preserved specimens with a protecting plate covering the aperture. Length up to 1.20 mm.; breadth 1.00 mm.; thickness 0.75 mm.

This species described by Rzehak from Europe seems to be identical with the very common species of the American Claiborne. The aperture is broader and more rounded than the later species in which the opening becomes increasingly elongate.

CERATOBULIMINA ALAZANENSIS Cushman and Harris, new species
Plate 29, figures 5 *a-c*; Plate 30, figures 3-5

Test very slightly longer than broad, periphery broadly rounded, usually 6 chambers in the last-formed whorl; sutures distinct, slightly depressed, not limbate; wall smooth and polished; aperture more elongate than in the older species and nearer the axis of coiling. Length 0.75 mm.; breadth 0.60 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 17559) from Alazan Clays, Arroyo, Camalla, Tepitzintla-El Humo road, about 4 kms. E. of El Humo, Mexico, collected by Dr. T. Wayland Vaughan.

It also occurs at other stations in the Alazan Clays of Mexico.

The chambers of the last-formed coil gradually become wider and more involute on the dorsal side than in any other older species, and in this character resemble the later Tertiary species.

OLIGOCENE SPECIES

CERATOBULIMINA CONTRARIA (Reuss)

Plate 29, figures 6 *a-c*

Rotalina contraria REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 76, pl. 5, fig. 37.

Ceratobulimina contraria TOULA, Jahrb. Geol. Reichsanst., vol. 64, 1920, p. 665.

The original figure of this species is copied here. It seems that the fore-shortening in the figure is not correct, and the specimen appears flatter than it probably should. We have specimens that may be referred to this species, but none from the Hermsdorf locality. The aperture as figured is more elongate than the older species, and more nearly approaches some of the Australian Miocene and Recent forms. There are 7 chambers in the last-formed whorl.

The types were from the Oligocene of Hermsdorf, near Berlin.

Numerous fossil and recent forms have been referred to this species.

MIOCENE SPECIES

CERATOBULIMINA HAUERII (d'Orbigny)

Plate 29, figures 8 *a-c*; Plate 30, figures 1, 2

Rotalina hauerii D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 151, pl. 7, figs. 22-24.

Test nearly as broad as long, periphery rounded, test compressed, usually 7 or 8 chambers in the last-formed whorl, distinct, those of the last-formed coil somewhat more involute toward the growing end; wall smooth and polished; sutures distinct, slightly depressed; aperture rather large, the axis pointing slightly to the dorsal side of the axis of coiling, covered in well preserved specimens with a thin protecting plate with a slightly upturned border covering the umbilical region. Length 1 mm.; breadth 0.85 mm.; thickness 0.50 mm.

We have numerous specimens of this species from the type locality of Baden near Vienna. The characters are rather constant, the protecting plate being very well developed. In many respects it seems to be closely related to the Mexican form and more closely still to the Australian form.

CERATOBULIMINA HAUERII (d'Orbigny), var. **AUSTRALIS** Cushman and Harris, new variety

Plate 29, figures 10 *a-c*; Plate 30, figures 6-10

Variety differing from the typical form in the slightly less broad form and the narrower and slightly more elongated aperture.

Holotype (Cushman Coll. No. 7031) from Balcombian deposits of Grices Creek, Victoria, Australia.

In the Janjukian Marl from Bird Rock Cliffs, Torquay, Victoria, Australia, there is a form figured (Pl. 30, figs. 6, 7) which seems to have the aperture at a slightly different angle to the axis of coiling, and which should be studied further.

CERATOBULIMINA DEHISCENS (Heron-Allen and Earland)

Plate 29, figures 7 *a-c*

Bulimina convoluta Williamson, var. *dehiscens* Heron-Allen and Earland, Journ. Roy. Micr. Soc., 1924, p. 143, pl. 8, figs. 26-28.

Specimens of this species are fairly common in the Filter Quarry material of the Miocene of Moorabool River, Victoria, Australia. The species is more elongate than the others and the aperture elongate, the whole test elongates especially in the last growth. It is much compressed.

CERATOBULIMINA PACIFICA Cushman and Harris, new species

Plate 29, figures 9 *a-c*

Test nearly as broad as long, periphery very broadly rounded, the last chambers becoming somewhat involute on the dorsal side; usually 6 chambers in the last-formed whorl; sutures distinct, very slightly depressed; aperture narrow elongate, narrowing toward the middle of the face. Length 0.90 mm.; breadth 0.65 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 1472) from *Albatross* Station D5236, E. Coast of Mindanao, Philippines, in 494 fathoms.

This is the most rounded of the species so far discussed. It shows its relationship to certain other species of the Indo-Pacific which possibly belong under *Ceratobulimina,* but the types of which are not available at the moment for study. There is a tendency to reduce the number of chambers and for the dorsal side to become more involute in its later development.

EXPLANATION OF PLATE 29

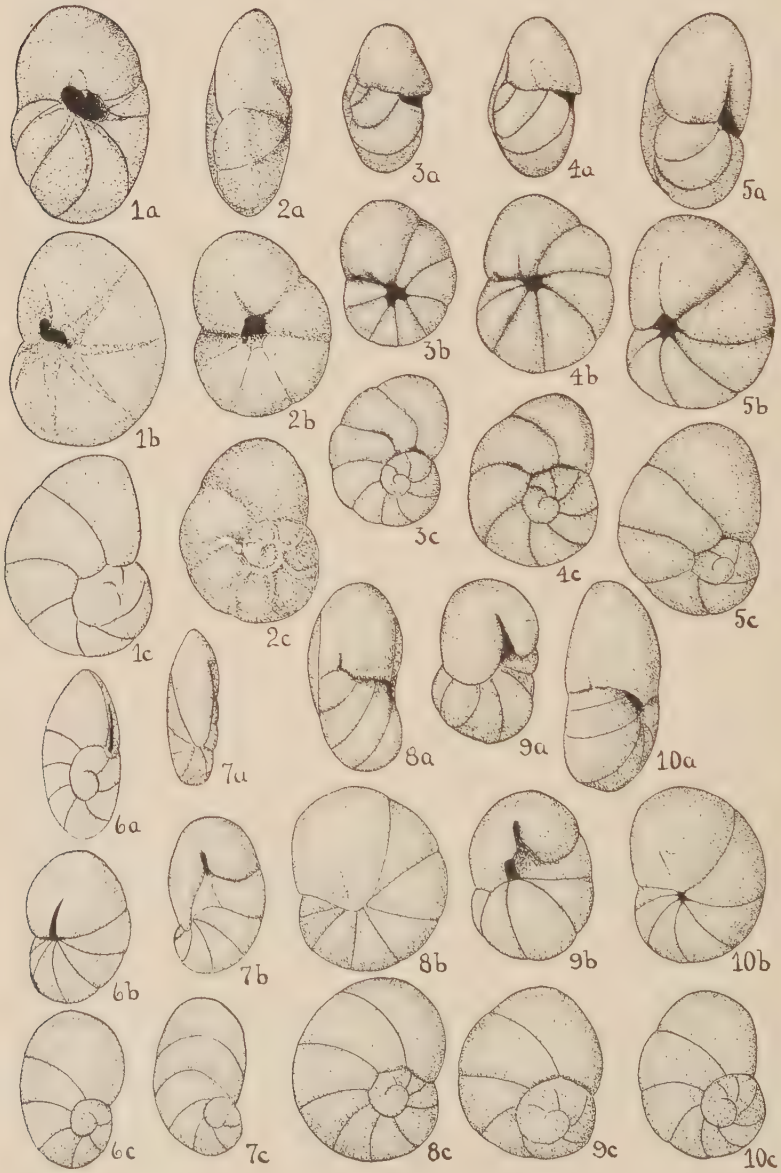
In all figures *a* is peripheral view; *b*, ventral view; *c*, dorsal view.

FIGS. 1 *a–c*. *Ceratobulimina cretacea* Cushman and Harris, n. sp. × 65.
FIGS. 2 *a–c*. *Ceratobulimina perplexa* (Plummer). × 65. After Plummer.
FIGS. 3 *a–c*. *Ceratobulimina eximia* (Rzehak). After Rzehak.
FIGS. 4 *a–c*. *Ceratobulimina eximia* (Rzehak). × 35. Claiborne specimen.
FIGS. 5 *a–c*. *Ceratobulimina alazanensis* Cushman and Harris, n. sp. × 65.
FIGS. 6 *a–c*. *Ceratobulimina contraria* (Reuss). After Reuss.
FIGS. 7 *a–c*. *Ceratobulimina dehiscens* (Heron-Allen and Earland). × 65. From the Miocene of Australia.
FIGS. 8 *a–c*. *Ceratobulimina hauerii* (d'Orbigny). × 40. Specimen from Baden.
FIGS. 9 *a–c*. *Ceratobulimina pacifica* Cushman and Harris, n. sp. × 55.
FIGS. 10 *a–c*. *Ceratobulimina hauerii* (d'Orbigny), var. *australis* Cushman and Harris, n. var. × 40.

EXPLANATION OF PLATE 30

All figures × 40.

FIGS. 1, 2. *Ceratobulimina hauerii* (d'Orbigny).
FIGS. 3–5. *Ceratobulimina alazanensis* Cushman and Harris, n. sp.
FIGS. 6–10. *Ceratobulimina hauerii* (d'Orbigny), var. *australis* Cushman and Harris, n. var. Fig. 10, holotype.
FIG. 11. *Ceratobulimina cretacea* Cushman and Harris, n. sp.
FIGS. 12–16. *Ceratobulimina eximia* (Rzehak).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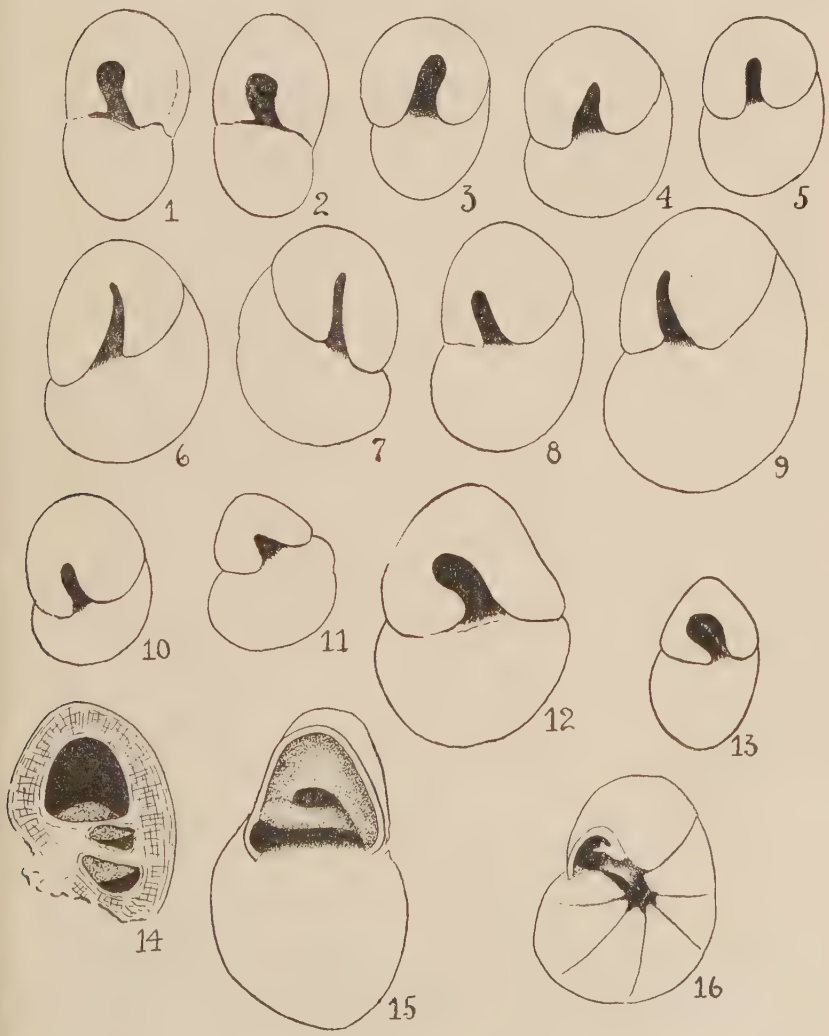
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52. EPISTOMINA ELEGANS (D'ORBIGNY) AND E. PARTSCHIANA (D'ORBIGNY)

By Joseph A. Cushman

There have been many erroneous ideas as to the actual characters of many of the early species of the foraminifera. This has been due to a study of the figures without reference to either the actual types or to topotype material. Very often a study of the types or topotypes will give a true idea of the species, and correct the previous errors which may otherwise be easily perpetuated.

In 1826, d'Orbigny named *Rotalia* (*Turbinulina*) *elegans* (Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 54). There is no figure given but a reference is given to Soldani ("*Hammoniformis trochiformis*" Sold. App., tab. 2, fig. R.="Nautili *ammoniformes* sive *trochiformes*," Soldani, Test vol. 2, App., 1798, pl. 2, fig. R.). There is no locality given by d'Orbigny, but Soldani's specimens were from the Pliocene of Coroncina, Italy. The species is common at Coroncina, and I have a large suite of specimens for study. No description is given by d'Orbigny of this species, and its characters must rest upon Soldani's figure and the type specimen which is in the Soldani Collection at Siena, as well as topotype material from Coroncina. This will be described on a later page.

In 1846, d'Orbigny described and figured *Rotalina partschiana* (Foram. Foss. Bass. Tert. Vienne, 1846, p. 153, pl. 7, figs. 28-30; pl. 8, figs. 1-3) from the Miocene of the Vienna Basin. It is rare at Nussdorf but abundant at Baden. A study of the large suites of specimens available especially from Baden shows that the figures given of this species have not been correctly interpreted. The sutures on the ventral side especially are limbate, but are not strongly raised above the surface as has been thought by some writers. The figures show the thickened sutures which in slightly eroded specimens both recent and fossil stand out when the wall is worn away. d'Orbigny's description gives 9-11 chambers in the last whorl but the megalospheric form usually has 7-8 while the microspheric form may have as many as 14. The test is much more convex in the megalospheric than in the microspheric form. It may be noted that the two figures of the ventral

side given by d'Orbigny have respectively 8 or 9 chambers while the dorsal views seem to show more.

I have examined many specimens from various formations from the Miocene onward and have been unable to find distinctions that are constant and are not due to microspheric or megalospheric forms or to differences in thickness of the chamber wall.

Genus EPISTOMINA Terquem, 1883

Epistomina TERQUEM, Bull. Soc. géol. France, ser. 3, vol. 11, 1883, p. 37, (Genotype *E. regularis* TERQUEM).

Rotalia (*Turbinulina*) (in part), D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 276.

Rotalia (in part) D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 153.

Pulvinulina (in part) PARKER and JONES, Phil. Trans., vol. 155, 1865, p. 397, and later authors.

Placentula BERTHELIN, Bull. Soc. géol. France, ser. 3, vol. 11, 1882, p. 16 (not *Placentula* LAMARCK, 1822).

Test free, biconvex, trochoid, all whorls visible from the dorsal side, only the last-formed one from the ventral side; chambers numerous, usually distinct, not inflated; sutures distinct, of very solid material, limbate, on the dorsal side oblique, on the ventral side obliquely radiate, strongly limbate in nearly all species, sometimes strongly raised into a highly ornate surface, umbilicus usually filled and umbonate; wall finely perforate, usually thin between the sutures, especially on the dorsal side, often with irregular thickened areas appearing light colored against the darker translucent portion; apertures of two sorts, one in the normal position for the Rotaliidae, at the inner margin of the ventral side of the chamber or in the face itself, the other elongate, just below the periphery and in the axis of coiling, in later chambers usually filled with clear shell material.

There are a number of species from the Jurassic on. One species that I have in abundance from the Russian Jurassic is very similar to the later species but those of the Cretaceous in particular are often highly ornate. The genus is widely distributed at the present time.

It may be noted here that *Truncatulina favosoides* Egger, (Abhandl. Kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 150, pl. 20, figs. 22-25) is an *Epistomina*. The type is in the collection at Munich, and I have in my collection numerous specimens from the type locality of Gerhardsreuth and others

of Egger's localities. There are numerous interesting species in the European Jurassic and Cretaceous which cannot be adequately dealt with in this short paper.

EPISTOMINA ELEGANS (d'Orbigny)

"Nautili *ammoniformes* sive *trochiformes*," SOLDANI, Test., vol. 2, App., 1798, pl. 2, fig. R.

Rotalia (*Turbinulina*) *elegans* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 54, (not *Rotalia elegans*, l. c. p. 272, No. 6=nomen nudum).

Rotalina partschiana D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 153, pl. 7, figs. 28-30; pl. 8, figs. 1-3.

Pulvinulina repanda, var. *elegans* PARKER and JONES, Phil. Trans., vol. 155, 1865, p. 397, pl. 16, figs. 44-46.

Pulvinulina partschiana REUSS, Sitz. Akad. Wiss. Wien, vol. 55, 1867, p. 104.—KARRER, l. c., vol. 58, 1868, p. 186.—H. B. BRADY, Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 699, pl. 105, figs. 3 *a-c*, text fig. 21.—EGGER, Abhandl. Kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 410, pl. 17, fig. 43; pl. 18, figs. 25-27.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 42.—FLINT, Ann. Rep't. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 3.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 162.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.—TOULA, Jahrb. Kais.-Kön. Geol. Reichs., vol. 64, 1914 (1915), p. 666.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 5, 1915, p. 64.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 260.—CUSHMAN, Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 344.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zool., vol. 6, 1922, p. 218.—MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 62, 1923, p. 352.

Pulvinulina elegans PARKER, JONES and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 174, pl. 12, fig. 142.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 699, pl. 105, figs. 4-6.—H. B. BRADY, PARKER and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 228, pl. 46, fig. 2.—J. WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 492.—SILVESTRI, Mem. Accad. Pont. Nuovi Lincei, vol. 9, 1893, p. 214.—AMICIS, Boll. Soc. Geol. Ital., vol. 12, 1893, p. 163.—EGGER, Abhandl. Kön. bay. Akad. München, Cl. II, vol. 18, 1893, p. 410, pl. 18, figs. 37-39.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 97, pl. 16, fig. 808.—AMICIS, Nat. Sicil., Ann. XIV, 1895, p. 119.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 42.—SILVESTRI, Atti Accad. Sci. Acireale, vol. 7, 1896, p. 88.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 76.—FLINT, Rep't. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 1.—JONES, Foram. Crag, pt. 4, 1897, p. 324, pl. 7, figs. 32 *a*, *b*.—KIAER, Rep't. Norwegian Fish. & Mar. Invest., vol. 1, No. 7, 1900, p. 47.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, 1902, p. 58.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 501.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 161.—CHAPMAN, Subantarctic Islands of New Zealand, 1909, p. 362; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 288; Journ. Linn. Soc. Zool., vol.

30, 1910, p. 421.—SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 112, pl. 3, fig. 3.—BAGG, U. S. Geol. Surv. Bull. 513, 1912, p. 86, pl. 26, figs. 11-15.—HERON-ALLEN and EARLAND, Proc. Roy. Irish Acad., vol. 31, pt. 64, 1913, p. 138.—TOULA, Jahrb. Kais.-kön. Geol. Reichs., vol. 64, 1914 (1915), p. 645.—PEARCEY, Trans. Roy. Soc. Edinburgh, vol. 49, 1914, p. 1029.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 5, 1915, p. 63, pl. 26, fig. 3.—CHAPMAN, Biol. Res. *Endeavour*, vol. 3, pt. 1, 1915, p. 32.—HERON-ALLEN and EARLAND, Trans. Zool. Soc., vol. 20, 1915, p. 717; Trans. Linn. Soc. London, vol. 11, 1916, p. 277; Journ. Roy. Micr. Soc., 1916, p. 52.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 260.—CUSHMAN, Proc. U. S. Nat. Mus., vol. 56, 1919, p. 631; Bull. 100, U S. Nat. Mus., vol 4, 1921, p. 342.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 218; Journ. Roy. Micr. Soc., 1924, p. 180; Journ. Linn. Soc. Zool., vol. 35, 1924, p. 637.—CUSHMAN, Bernice P. Bishop Museum, Bull. 27, 1925, p. 134.

Epistomina partschiana CUSHMAN, Bull. Scripps Inst. Ocean., Tech. Ser., vol. 1, No. 10, 1927, p. 163, pl. 5, figs. 4, 5.

Epistomina bradyi GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 60, pl. 10, fig. 1.

Epistomina flinti GALLOWAY and WISSLER, l. c., p. 61, pl. 9, fig. 16.

Test biconvex, either with the sides nearly equally convex or the ventral side more strongly so especially in the microspheric form, periphery rounded or in small specimens more acute; chambers usually distinct, typically 7-9 in the megalospheric form, increasing to as many as 14 in the largest microspheric specimens; sutures distinct, limbate, but not raised, on the dorsal side strongly oblique, on the ventral side obliquely radial ending at the center in an umbonate mass; wall finely perforate, in the thin walled specimens often showing a complex pattern of thickenings, in thick walled specimens opaque; aperture usually narrow on the ventral side at the base of the last-formed chamber toward the periphery with a supplementary aperture in the axis of coiling, parallel to the peripheral margin and just ventral to it, elongate. Diameter up to 2 mm. in microspheric specimens.

Plate 31, figs. 1-3, all from the Pliocene of Coroncina, Italy, the type locality of *Epistomina elegans* (d'Orbigny) give the characters of the type. Plate 32, figs. 7, 8 are from the type figure of Soldani. Plate 31, figs. 4-6 are from Baden in the Miocene of the Vienna Basin, and represent typical *E. partschiana* (d'Orbigny).

These specimens were selected at random from a large series from each locality and show very little if any real differences. Both series have specimens in which the pattern of the wall is

apparent, due to unequal thickening and the same character is widely spread in the recent material in the present oceans.

The species is very thickly distributed and often very abundant as though it might perhaps be pelagic at some early stage. I have it from the type localities of Coroncina and Baden as well as other localities in the Miocene and Pliocene of Europe, from the Pliocene and Pleistocene of California, from the Miocene of Australia and from very many localities in the present oceans. There seems to be very little variation in the species in all this series except such as may be accounted for in the difference in characters usually present in megalospheric and microspheric forms.

Many of the smooth forms from Eocene material and some from the Cretaceous and even Jurassic are close to this species but enough differences are present to distinguish them.

In the more highly ornamented species of the Cretaceous there are a number of well characterized species.

Only those references are given which from a study of my own material seem to belong here.

Rotalina pleurostomata Schlumberger, (Feuille des Jeunes Naturalistes, ann. XIII, 1883, p. 25, pl. 3, figs. 5 *a, b*), probably is the same as *Epistomina elegans* (d'Orbigny). The figures are not at all of a normal form, but Schlumberger in a note says that some of the shadows and characters of his original drawings have been exaggerated by the lithographer and leave much to be desired. Such figures might easily be misinterpreted.

Brady places *Rotalia flosculiformis* Schwager (*Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 262, pl. 7, fig. 109) as a synonym of *"Pulvinulina partschiana."* I have some of Schwager's original material from the Pliocene of Kar Nicobar and a search of this seems to show that the form called by Schwager *R. flosculiformis* which is close to the figure given by him is in reality a *Pulvinulinella* and not *Epistomina*. It is broadly keeled and has the aperture of *Pulvinulinella* and no sign of the aperture of *Epistomina*. No specimens of *Epistomina* were found in the material I have nor in my Pliocene material from Sumatra and Borneo.

EXPLANATION OF PLATE 31

In all figures *a* is peripheral view; *b*, dorsal view; *c*, ventral view. All × 65.

FIGS. 1–3. *Epistomina elegans* (d'Orbigny). Specimens from the Pliocene of Coroncina, Italy.

FIGS. 4–6. *Epistomina elegans* (d'Orbigny). (*E. partschiana* (d'Orbigny)) from the Miocene of Baden near Vienna.

EXPLANATION OF PLATE 32

All figures *Epistomina elegans* (d'Orbigny).

FIG. 1. Microspheric specimen from the Miocene of Baden in peripheral outline. × 45.

FIG. 2. Microspheric specimen from off the Pacific Coast of America. × 45.

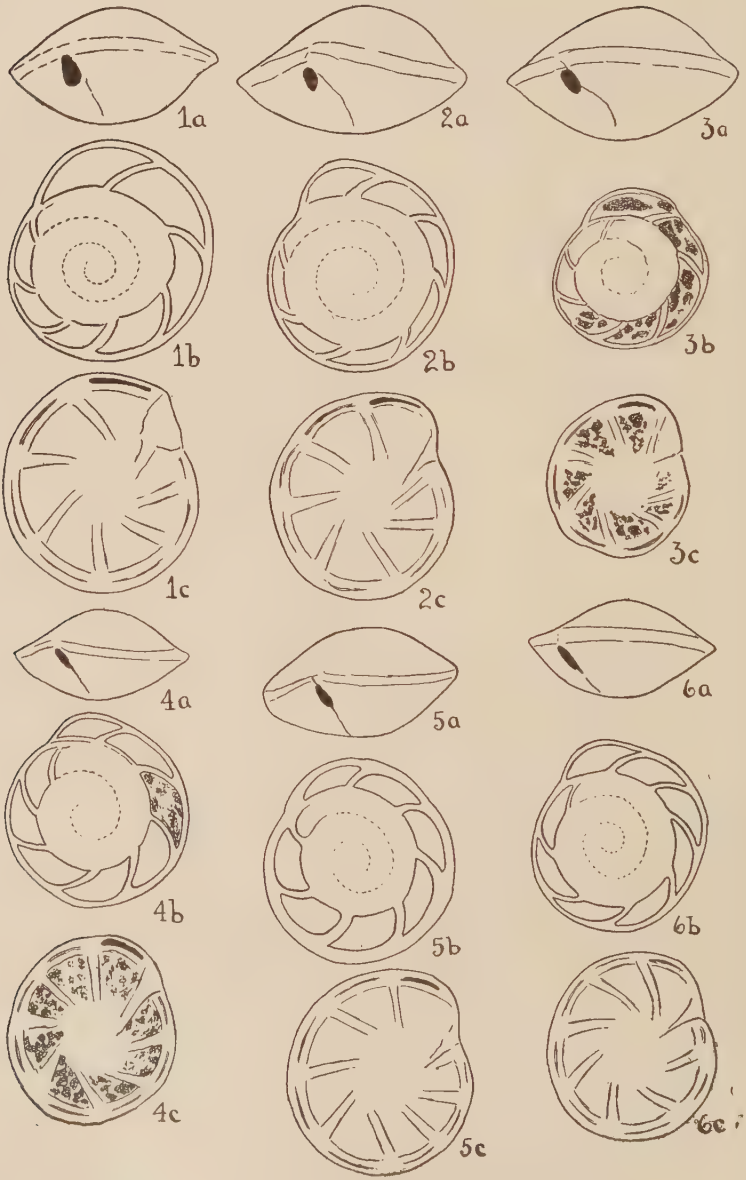
FIG. 3. Microspheric specimen from the Gulf of Mexico. × 45.

FIGS. 4 *a*, *b*. Megalospheric specimen from the same station as fig. 2. × 45. *a*, peripheral view; *b*, dorsal view.

FIGS. 5 *a*, *b*. Megalospheric specimen from off Fowey Rocks, Fla. × 65. *a*, peripheral view; *b*, dorsal view.

FIGS. 6 *a*, *b*. Megalospheric specimen from Pico formation (Pliocene) of Los Angeles Basin. × 64. *a*, peripheral view; *b*, dorsal view.

FIGS. 7, 8. From Soldani's original figures. 7, ventral view; 8, dorsal view.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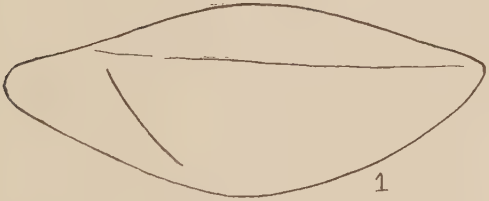
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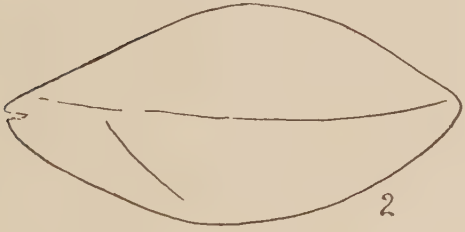
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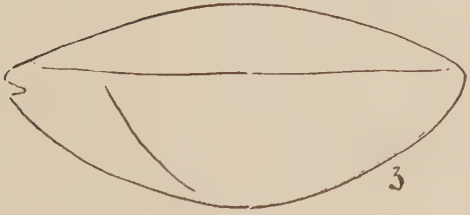
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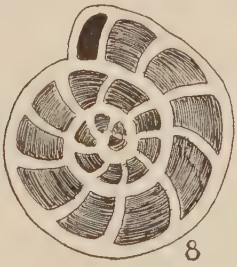
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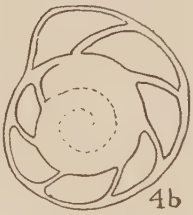
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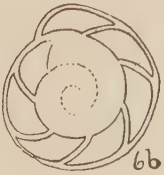
5a


5b


6a


6b

53. THE DESIGNATION OF SOME GENOTYPES IN THE FORAMINIFERA

By Joseph A. Cushman

Many of the genera of the foraminifera as in all groups of the animal kingdom are represented by single species. In these monotypic genera, the genotypes are of course established. In others, although the genus may now have a number of known species, at the time of the erection of the genus but a single species was known, and as far as the genotype is concerned, it is also a monotypic genus. In many other genera where several species were included by the original author, subsequent workers have designated genotypes. A few genera which are recognized have not had genotypes designated. To make more definite the characters of a number of genera, genotypes are here designated for them.

Masonella H. B. Brady, 1889. The first species, *Masonella planulata* H. B. Brady, Ann. Mag. Nat. Hist., ser. 6, vol. 3, p. 295, fig. 1, is here designated as the genotype.

Nodosinella H. B. Brady, 1876. The first species, *Nodosinella digitata* H. B. Brady, Carbonif. Foram. Pal. Soc., vol. 30, 1876, p. 103, pl. 7, figs. 1-3, is here designated as the genotype.

Silicina Bornemann, 1874. The first species, *Silicina polymorpha* (Terquem)=*Involutina polymorpha* Terquem, Mém. Acad. Imp. Metz., vol. 44, 1863, p. 432, pl. 10, figs. 23 *a-c*, is designated as the genotype of *Silicina*.

Problematina Bornemann, 1874. The first species, *Problematina deslongchampsi* Terquem, Mém. Acad. Imp. Metz., vol. 44, 1863, p. 432, pl. 10, fig. 22 *a*, *b*, is designated as the genotype of *Problematina*.

Agathammina Neumayr, 1887. The first species, *Agathammina pusilla* (Geinitz)=*Serpula pusilla* Geinitz, Verstein. deutsch. Zechsteingebirges und Rothliegenden, Heft 1, 1846, p. 6, pl. 3, figs. 3-6, is designated as the genotype of *Agathammina*.

Cornuspira Schultze, 1854. In 1916, I designated *Cornuspira foliacea* (Philippi) as the genotype of *Cornuspira*. This was not one of the names used by Schultze at the time he erected the genus. *Cornuspira planorbis* Schultze as the first species should

be designated as the genotype (Organismus Polythalamien, 1854, p. 40, pl. 2, fig. 21). However, this species is apparently a synonym of *Cornuspira foliacea* (Philippi), and no change except in the matter of terminology is made.

Nouria Heron-Allen and Earland, 1914. The first species, *Nouria polymorphinoides* Heron-Allen and Earland, Trans. Zool. Soc. London, vol. 20, 1914, p. 376, pl. 37, figs. 1-15, is here designated as the genotype.

Stacheia H. B. Brady, 1876. The first species, *Stacheia marginulinoides* H. B. Brady, Carbonif. Foram., Pal. Soc., vol. 30, 1876, p. 112, pl. 7, figs. 16-21, is here designated as the genotype.

Glandulina d'Orbigny, 1826. The first species, *Glandulina laevigata* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 252, pl. 10, figs. 1-3, is here designated as the genotype.

Flabellina d'Orbigny, 1839. The first species placed by d'Orbigny under this genus, *Flabellina rugosa* d'Orbigny, Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 23, pl. 2, figs. 4, 5 and 7, is here designated as the genotype.

Globulina d'Orbigny, 1826. The first species, *Globulina gibba* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, Modèle No. 63, is here designated as the genotype.

Vitriwebbina Chapman, 1892. The first species figured by Chapman, *Vitriwebbina sollasi* Chapman, Geol. Mag., dec. 3, vol. 9, 1892, p. 53, pl. 2, figs. 1-3, is here designated as the genotype.

Bradyina Möller, 1878. The second species given by Möller, *Bradyina nautiliformis* Möller, Mem. Acad. Imp. Sci. St. Petersburg, ser. 7, vol. 25, No. 9, 1878, p. 83, pl. 3, figs. 4 *a-d*; pls. 10, figs. 3 *a, b*, is here designated as the genotype. The other earlier species is somewhat questionable.

Assilina d'Orbigny, 1826. The first species, *Assilina discoidalis* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 296, Modèle No. 88, is here designated as the genotype.

Spiroclypeus H. Douvillé, 1905. The first species, *Spiroclypeus orbitoideus* H. Douvillé, Bull. Soc. Géol. France, ser. 4, vol. 5, 1905, p. 460, is here designated as the genotype.

Dendritina d'Orbigny, 1826. The first species, *Dendritina arbuscula* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 285, pl. 15, figs. 6, 7, is here designated as the genotype.

Monalysidium Chapman, 1900. The first species given under this genus by Chapman, *Peneroplis* (*Monalysidium*) *sollasi*

Chapman, Journ. Linn. Soc. Zool., vol. 28, 1900, p. 3, pl. 1, fig. 6, is here designated as the genotype of *Monalysidium*.

Sorites Ehrenberg, 1838. *Sorites dominicensis* Ehrenberg, Abhandl. K. Akad. Wiss. Berlin, 1838, p. 134, is here designated as the genotype.

Heterohelix Ehrenberg, 1843. Two forms are given by Ehrenberg under his *Spiroplecta americana*. The form figured, Mikrogeologie, pl. 32, fig. 25, is here designated as the genotype of *Heterohelix*.

Guembelina Egger, 1899. The first species given by Egger, *Guembelina globulosa* (Ehrenberg)=*Textularia globulosa* Ehrenberg, Abhandl. K. Akad. Wiss. Berlin, 1838, p. 135, pl. 4, fig. 8, is here designated as the genotype of *Guembelina*.

Mimosina Millett, 1900. *Mimosina hystrix* Millett, Journ. Roy. Micr. Soc., 1900, p. 549, pl. 4, fig. 14, is here designated as the genotype after a study of the originals of the species given by Millett, now in the Collection of Heron-Allen and Earland in London.

Entosolenia Ehrenberg, 1848. Of the several species noted by Williamson, the first actually described in full, *Entosolenia lineata* Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 18, pl. 2, fig. 18, is here designated as the genotype.

Siphogenerina Schlumberger, 1883. I selected as the genotype, *Siphogenerina raphanus* (Parker and Jones), although this species was not included by Schlumberger at the time of his erection of the genus. The genotype should be designated as *Siphogenerina costata* Schlumberger which is however apparently a synonym of the earlier *S. raphanus* (Parker and Jones).

Ellipsoidina Seguenza, 1859. The first species, *Ellipsoidina ellipsoides* Seguenza, Eco Peloritans, ser. 2, vol. 5, 1859, fasc. 9, p. 12, pl., figs. 1-3, is here designated as the genotype.

Gyroidina d'Orbigny, 1826. The first species, *Gyroidina orbicularis* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, Modèle No. 13, is here designated as the genotype.

Asterigerina d'Orbigny, 1839. *Asterigerina carinata* d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminiférès," p. 118, pl. 5, fig. 25; pl. 6, figs. 1, 2, is here designated as the genotype.

Cycloloculina Heron-Allen and Earland, 1908. The first species, *Cycloloculina annulata* Heron-Allen and Earland, Journ. Roy. Micr. Soc., 1908, p. 536, pl. 12, figs. 1-7, is here designated as the genotype.

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

Hofker, J.

Die Foraminiferen aus dem Senon Limburgens. VI.

(Nat. Maan., Nat. Gen. Limburg, Jaarg. 16, No. 9, Sept. 30, 1927, pp. 125-128, 1 plate.) *Limburg.*

A paper devoted to structural details of *Polytrema minutum* and *Pulvinulina binkhorsti.*

Van der Vlerk, I. M., and J. H. F. Umbgrove.

Tertiaire Gidsforaminiferen van Nederlandsch Oost-Indië.

(Dienst van den Mijnbouw in Nederlandsch-Indië. Weten-Schappelijke Mededeelingen No. 6, 1927, pp. 1-31, 24 text figs., table.) *Bandoeng.*

A paper dealing with the index foraminifera of the East Indian region giving the distribution of the genera and a table of detailed stratigraphy of the region. The illustrations are for the most part beautifully executed diagrammatic figures showing the exterior, vertical and the equatorial sections. This is of pocket size and cloth covered for field use.

Vaughan, T. Wayland.

Larger Foraminifera of the Genus Lepidocyclina related to Lepidocyclina mantelli.

(Proc. U. S. Nat. Mus., vol. 71, Art. 8, 1927, pp. 1-5, pls. 1-4.) *Washington.*

One new species is described, and three other species and one variety figured.

Umbgrove, J. H. F.

Neogene Foraminiferen van de Soengei Beboeloe, Pasir (Zuidoost-Borneo). (Summary in English.)

(Wetensch. Med. Dienst Mijnb. Nederl.-Indië, No. 5, 1927, pp. 1-14, 2 pls.) *Weltevreden.*

A paper mostly on *Lepidocyclina* and *Miogypsina.*

Silvestri, A.

Sul Genere "Lepidorbitoides" A. Silvestri e di un Suo Nuovo giacimento.

(Mem. Pont. Accad. Sci. Nuovi Lincei, vol. 10, 1927, pp. 109-140, pl. 1.) *Rome.*

A treatment of eleven species referred to this genus. Two of the species are figured.

Tobler, Aug.

Neue Funde von obereocänen Grossforaminiferen in der nordperuanischen Küstenregion.

(Eclogae geol. Helv., vol. 20, No. 3, 1927, pp. 415-422, 1 text fig.) *Basel.*

The distribution, particularly of the orbitoids of this region, is given with a bibliography of papers relating to these forms in Peru.

Werenfels, A.

Geology of the Illescas Region, Northern Peru, (South America).

(Ecologae geol. Helv., vol. 20, No. 4, 1927, pp. 473-486, 1 plate, 4 text figs.) *Basel.*

A few species are noted, taken from the previous paper of Dr. Tobler's. The figures are maps, and the plate one of photographs of surface topography.

Hofker, J.

The Foraminifera of the Siboga Expedition. Part I. Families Tinoporidae, Rotaliidae, Nummulitidae, Amphisteginidae.

(Monograph IV, Siboga Exped., pt. 1, Nov. 1927, pp. 1-78, pls. I-XXXVIII, text figs. 1-11.) *Leiden.*

An exhaustive treatment with many detailed figures and sections of these groups. The plates show the finer structure, and some excellent technical methods for studying the internal structure are given.

Hodson, Floyd and Helen.

Short Cuts in Picking out and Sectioning Foraminifera.

(Bull. Amer. Assoc. Petr. Geol., vol. 10, No. 11, Nov. 1926, pp. 1173, 1174.) *Chicago.*

The use of heavy liquids, oxy-acetylene torch and acid are all noted.

Liebus, Adalbert.

Neue Beiträge zur Kenntnis der Eozänfauna des Krappfeldes in Kärnsten.

(Jahrb. Geol. Bund., vol. 77, 1927, pp. 333-392, pls. 12-14.) *Wien.*

There are 49 species and varieties of foraminifera with 8 described as new. A few other groups are briefly noted, and a six page bibliography given.

Woodring, W. P.

Marine Eocene Deposits on the East Slope of the Venezuelan Andes.

(Bull. Amer. Assoc. Petr. Geol., vol. 11, No. 9, Sept. 1927, pp. 992-996.) *Chicago.*

A discussion of the orbitoid foraminifera found and their relationships to the species of Panama, the West Indies and elsewhere.

Cushman, Joseph A.

Notes on Foraminifera in the Collection of Ehrenberg.

(Journ. Washington Acad. Sci., vol. 17, No. 19, Nov. 19, 1927, pp. 487-491.) *Washington.*

Some results of the study of Ehrenberg's original collection are given.

Cushman, Joseph A.

Some Foraminifera from the Cretaceous of Canada.

(Trans. Roy. Soc. Canada, Sect. IV, 1927, pp. 127-132, pl. 1.) *Ottawa.*

Twelve species mostly arenaceous are described, five of them new.

J. A. C.